

2002

MISSOURI

Minimum Standards for School Buses



School Transportation Section

Missouri Department of
Elementary and
Secondary Education

D. Kent King
Commissioner of Education

MINIMUM STANDARDS FOR SCHOOL BUSES

TABLE OF CONTENTS

Foreword	i	Identification.....	28
Section (1) General Provisions		Inside Height.....	29
Effective Date.....	1	Insulation	29
Scope	1	Interior	29
Federal Motor Vehicle Safety Standards.....	1	Lamps and Signals	30
Used School Buses	1	Metal Treatment.....	33
Changes in Specifications	1	Mirrors.....	33
Study of New Equipment.....	1	Mounting	33
Section (2) School Bus Types		Overall Length.....	34
Types A, B, C, and D School Buses	3	Overall Width.....	34
Section (3) Bus Chassis Specifications		Post Trip Safety Alarm (Optional).....	34
Air Cleaner.....	4	Public Address System.....	34
Axles.....	4	Reflective Material	34
Brakes	4	Rub Rails	35
Bumper, Front.....	5	Seat and Restraining Barriers	36
Certification.....	6	Steps	37
Clutch	6	Step Treads	38
Color.....	6	Stirrup Steps	38
Drive Shaft	7	Stop Signal Arm.....	38
Electrical System.....	7	Storage Compartment (Optional)	39
Engine Fire Extinguisher.....	9	Sun Shield	39
Exhaust System.....	9	Tailpipe	39
Fenders, Front Type C Vehicles.....	10	Towing Attachment Points.....	39
Frame	10	Traction Assisting Devices (Optional)	39
Fuel Tank.....	10	Trash Container and Holding Device.....	40
Governor.....	11	Undercoating.....	40
Heating System, Provision for.....	11	Ventilation.....	41
Horn.....	11	Wheelhousing.....	41
Instruments and Instrument Panel.....	11	Windows.....	42
Oil Filter	13	Windshield Washers	42
Openings	13	Windshield Wipers	42
Passenger Load	13	Wiring	42
Power and Gradeability	13	Section (5) Specifications for Specially	
Retarder System (Optional Equipment)	13	Equipped School Buses	
Road Speed Control	13	Introduction.....	45
Shock Absorbers.....	13	Definition	45
Steering Gear	14	General Requirements.....	45
Suspension Systems.....	14	Aisles	46
Throttle	14	Communications	46
Tires and Rims	14	Glazing	46
Transmission.....	15	Identification.....	46
Turning Radius.....	15	Passenger Capacity Rating.....	46
Undercoating.....	15	Power Lifts and Ramps	47
Section (4) Bus Body Specifications		Regular Service Entrance.....	52
Aisle	16	Restraining Devices.....	53
Back-Up Warning Alarm.....	16	Seating Arrangements	53
Battery	16	Securement and Restraint System for	
Bumper, Front.....	16	Wheelchair/MobilityAid and Occupant.....	53
Bumper, Rear	16	Special Light.....	59
Ceiling	17	Special Service Entrance.....	59
Certification.....	17	Special Service Entrance Doors.....	60
Chains	17	Support Equipment and Accessories.....	61
Color.....	17	Technology and Equipment, New	62
Construction.....	18	Appendices	
Crossing Control Arm.....	18	Alternative Fuels	63
Defrosters.....	19	Introduction.....	63
Doors.....	20	General Requirements	63
Emergency Exits.....	21	Characteristics	65
Emergency Equipment.....	22	Bibliography	75
Floors.....	23	Glossary.....	77
Handrails.....	23	School Bus Chassis and Body	81
Heating and Air Conditioning Systems	23	National School Bus Yellow.....	81
Hinges	27	Bus Body Heating System Test.....	81
		Noise Test Procedure.....	93
		Retroreflective Sheetting/Daytime Color.....	94
		Seat Upholstery Fire Block Test.....	95
		Camera View Area	95

Appendices (continued)

Guideline for the Safe Transportation of Pre-School Age Children in School Buses.....	98
Introduction.....	98
Recommendations for the Transportation Of Pre-School Age Children in School Buses	98
Child Safety Restraint System Defined.....	99
Child Safety Restraint System Guidelines.....	99
Test for Frontal Impact Crashworthiness.....	103
Purpose.....	103
Equipment to be Tested.....	103
Test Equipment	103
Sled performance.....	107
Preparation and Calibration of Test Results	110
Test Report.....	111
Performance Requirements.....	112
Frontal Sled Impact Test.....	114
Partial Engagement of Anchorage and Securement Components.....	115
Webbing Slippage at Tiedown Adjustment Devices	115
Specifications for Surrogate Wheelchair.....	116
Introduction.....	116
Specifications	116
Vehicle Ramp 36 CFR 1192.23.....	121
Appendix, Vehicle.....	122

MINIMUM STANDARDS FOR SCHOOL BUSES

FOREWORD

The revised minimum standards for school bus chassis and school bus bodies have been prepared in conformity with the Revised Statutes of Missouri (RSMo) for school bus transportation. The standards recommended by the 2000 National Conference on School Transportation and the Federal Motor Vehicle Safety Standards (FMVSS) promulgated by the United States Department of Transportation were used as guides in developing these Missouri Standards.

The minimum standards appearing herein have been officially adopted by the State Board of Education in compliance with Section 304.060, RSMo., which reads, in part:

" . . . The state board of education shall adopt and enforce regulations not inconsistent with law to cover the design and operation of all school buses used for the transportation of school children when owned and operated by any school district or privately owned and operated under contract with any school district in this state, and such regulations shall by reference be made a part of any such contract with a school district...Every school district, its officers and employees, and every person employed under contract by a school district shall be subject to such regulations . . ."

The standards herein adopted shall be considered minimum. The writing of specifications and the purchase of equipment may exceed the adopted minimum standards in safety and quality. the standards are adopted to provide minimum standards statewide consistent with safety and economy and to eliminate the manufacture of unsafe school buses. It is believed that these standards are sufficiently flexible to permit opportunity for use of new inventions and improvements which will assure greater efficiency and safety.

This book is divided into five sections: Section 1 General Provisions, Section 2 School Bus Types, Section 3 Bus Chassis Specifications, Section 4 Bus Body Specifications, and Section 5 Specifications for Specially Equipped School Buses.

GENERAL PROVISIONS

EFFECTIVE DATE

These specifications apply respectively to school buses with a body tag "build date" later than June 30, 2002.

SCOPE

The specifications contained herein shall apply to all school buses, manufactured after the effective date, used to transport Missouri public school students to or from school or any place for educational purposes.

FEDERAL MOTOR VEHICLE SAFETY STANDARDS (FMVSS)

All motor vehicles with a passenger capacity of more than 10, including the driver, used to transport school students are required to meet the Federal Motor Vehicle Safety Standards (FMVSS) school bus specifications.

All school buses shall be equipped as required by the minimum specifications contained herein and as required by applicable FMVSS. In the event of a conflict between the requirements of an applicable FMVSS, as referred to in this section, and the minimum specifications contained in this regulation, the requirements of the FMVSS shall control.

USED SCHOOL BUSES

A used school bus purchased for use in Missouri by or for a public school district shall meet all of the legal requirements of the Missouri Revised Statutes for motor vehicles and shall meet the Missouri Minimum Standards for School Buses that were in effect on the date that the vehicle was manufactured plus any changes made on a retroactive basis.

CHANGES IN SPECIFICATIONS

Any part of these specifications may be changed at any time by addenda adopted by the State Board of Education.

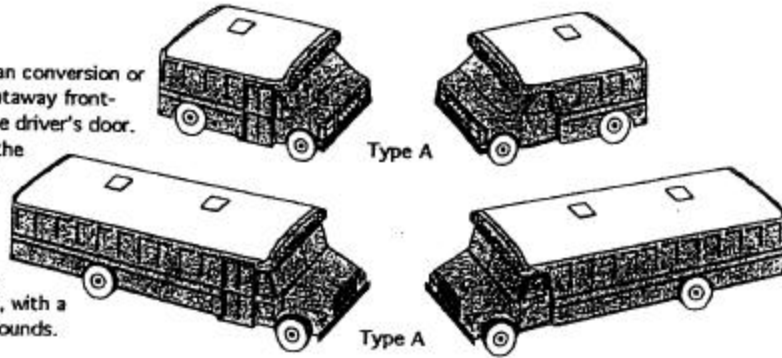
STUDY OF NEW EQUIPMENT

The Missouri Department of Elementary and Secondary Education retains authority for the Director of School Governance to authorize testing of new equipment on school buses. A written request to test new equipment must be submitted to the Director of School Governance for approval prior to the installation or use of the new equipment. The request shall specify a period of time for the test not to exceed one school year. After receiving a written request, the Director of School Governance will analyze the need for the new equipment and the related safety issues involved and issue a written decision within 15

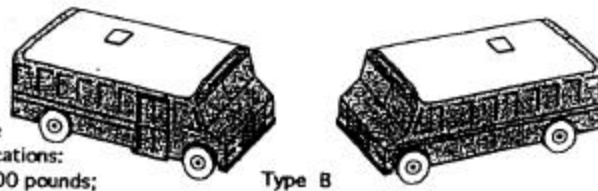
working days to the individual making the request. Upon completion of the test, a written report by the authorized tester shall be submitted to the Director of School Governance for analysis. If the equipment test provides additional safety for pupils an addendum to these standards may be issued by the Department.

SCHOOL BUS TYPES

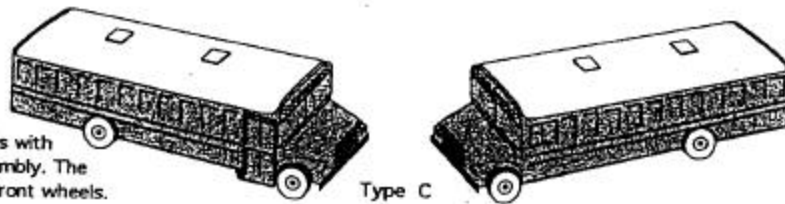
A Type "A" school bus is a van conversion or bus constructed utilizing a cutaway front-section vehicle with a left side driver's door. The entrance door is behind the front wheels. This definition includes two classifications: Type A1, with a Gross Vehicle Weight Rating (GVWR) less than or equal to 10,000 pounds; and Type A2, with a GVWR greater than 10,000 pounds.



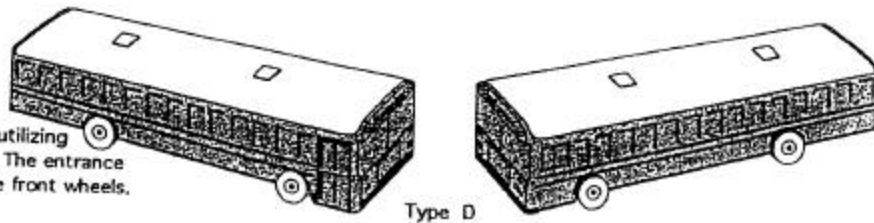
A Type "B" school bus is constructed utilizing a stripped chassis. The entrance door is behind the front wheels. This definition includes two classifications: Type B1, with a GVWR less than or equal to 10,000 pounds; and Type B2, with a GVWR greater than 10,000 pounds.



A Type "C" school bus is constructed utilizing a chassis with a hood and front fender assembly. The entrance door is behind the front wheels.



A Type "D" school bus is constructed utilizing a stripped chassis. The entrance door is ahead of the front wheels.



BUS CHASSIS SPECIFICATIONS

AIR CLEANER

- A. A dry element type air cleaner shall be provided.
- B. All diesel engine air filters shall include a latch-type restriction indicator that retains the maximum restriction developed during operation of the engine. The indicator should include a reset control so the indicator can be returned to zero when desired.

AXLES

The front and rear axle and suspension systems shall have a gross axle weight rating (GVWR) at ground commensurate with the respective front and rear weight loads that will be imposed by the bus.

BRAKES: GENERAL

- A. The chassis brake system shall conform to the provisions of FMVSS No. 105, No. 106 and No. 121 applicable.
- B. The anti-lock brake system (ABS), provided in accordance with FMVSS No. 105 or No. 121, shall provide wheel speed sensors for each front wheel and for each wheel on at least one rear axle. The system shall provide anti-lock braking performance for each wheel equipped with sensors. (Four Channel System.)
- C. All brake systems shall be designed to permit visual inspection of brake lining wear without removal of any chassis component(s).
- D. The brake lines, booster-assist lines, and control cables shall be protected from excessive heat, vibration and corrosion and installed in a manner which prevents chafing.
- E. The parking brake system for either air or hydraulic service brake systems may be of a power assisted design. The power parking brake actuator should be a push-pull device located on the instrument panel within seated reach of a 5th percentile female driver. As an option, the parking brake may be set by placing the automatic transmission shift control mechanism in the "park" position.

- F. The power-operated parking brake system may be interlocked to the engine key switch. Once the parking brake has been set and the ignition switch turned to the “off” position, the parking brake cannot be released until the key switch is turned back to the “on” position.

BRAKES: HYDRAULIC

Buses using a hydraulic-assist brake shall be equipped with audible and visible warning signals that provide a continuous warning to the driver of a loss of fluid flow from the primary source and of a failure of the back-up pump system.

BRAKES: AIR

- A. The air pressure supply system shall include a desiccant-type air dryer installed according to the manufacturers’ recommendations. The air pressure storage tank system may incorporate an automatic drain valve.
- B. The Chassis manufacturer should provide an accessory outlet for air operated systems installed by the body manufacturer. This outlet shall include a pressure protection valve.
- C. For air brake systems, an air pressure gauge shall be provided in the instrument panel capable of complying with CDL pre-trip inspection requirements.
- D. All air brake-equipped buses may be equipped with a service brake interlock. The parking brake cannot be released until the brake pedal is depressed.
- E. Air brake systems may include a system for anti-compounding of the service brakes and parking brakes.
- F. Air brakes shall have both a visible and audible warning device whenever the air pressure falls below the level where warnings are required under FMVSS No. 121.

BUMPER: FRONT

- A. School buses shall be equipped with a front bumper. The front bumper shall be furnished by the chassis manufacturer for all school bus types by the chassis manufacturer unless there is a specific agreement between the chassis manufacturer and body manufacturer.
- B. The front bumper shall be of pressed steel channel or equivalent material (except Type A buses having a GVWR of 14,500 pounds or less which may be OEM supplied) at least 3/16" thick and not less than 8" wide

(high). It shall extend beyond forward-most part of the body, grille, hood, and fenders and shall extend to the outer edges of the fenders at the bumper's top line.

- C. The front bumper, except breakaway bumper ends, shall be of sufficient strength to permit pushing a vehicle of equal gross vehicle weight without permanent distortion to the bumper, chassis or body.
- D. Tow eyes or hooks may be furnished and attached so they do not project beyond the front bumper. Tow eyes or hooks attached to the frame chassis may be furnished by the chassis manufacturer. This installation shall be in accordance with the chassis manufacturer's specifications. **NOTE:** Rear tow eyes are addressed in the Bus Body Specifications under Towing Attachment points.
- E. The bumper shall be designed or reinforced so that it will not deform when the bus is lifted by a chain that is passed under the bumper (or through the bumper if holes are provided for this purpose) and attached to both tow eyes. For the purpose of meeting this specifications, the bus shall be empty and positioned on a level, hard surface and both tow eyes shall share the load equally.

CERTIFICATION

The chassis manufacturer, upon request of the Missouri Department of Elementary and Secondary Education, shall certify that its product meets the state's minimum standards on items not covered by the FMVSS certification requirements of 49 CFR, Part 567.

CLUTCH

- A. Clutch torque capacity shall be equal to or greater than the engine torque output.
- B. A starter interlock shall be installed to prevent actuation of the starter if the clutch pedal is not depressed.

COLOR

- A. The chassis, including wheels and front bumper, shall be black. Body cowl, hood, and fenders shall be in National School Bus Yellow (NSBY.) The flat top surface of the hood may be non-reflective black or NSBY. (See Appendix B.)
- B. Demountable rims, if used, may be silver, gray, white, yellow or black as received from the wheel manufacturer.

DRIVE SHAFT

The drive shaft shall be protected by a metal guard or guards around the circumference of the drive shaft to reduce the possibility of its whipping through the floor or dropping to the ground, if broken.

ELECTRICAL SYSTEM

A. Battery

1. The storage batteries shall have minimum cold cranking capacity rating (cold cranking amps) equal to the cranking current required for 30 seconds at 0 degrees Fahrenheit and a minimum reserve capacity rating of 120 minutes at 25 amps. Higher capacities may be required, depending upon optional equipment and local environmental conditions.
2. Since all batteries are to be secured in a sliding tray in the body, chassis manufacturers shall mount the battery temporarily on the chassis frame, except that van conversion or cutaway front-section chassis may be secured in accordance with the manufacturer's standard configuration. In these cases, the final location of the battery and the appropriate cable lengths shall be agreed upon mutually by the chassis and body manufacturer. However, in all cases the battery cable provided with the chassis shall have sufficient length to allow some slack.

B. Alternator

1. All Type A-2 and Type B buses with a GVWR of 15,000 lbs or less shall have a minimum 100 ampere alternator.
2. Type A-2 and Type B buses over 15,000 lbs GVWR and all Type C and Type D buses shall be equipped with a heavy-duty truck or bus-type alternator meeting SAE J 180, having a minimum output rating of 100 amperes or higher, and should produce a minimum current output of 50 percent of the rating at engine idle speed.
3. Buses equipped with an electrically powered wheelchair lift, air conditioning or other accessories may be equipped with a device that monitors the electrical system voltage and advances the engine idle speed when the voltage drops to, or below, a pre-set level.
4. A belt alternator drive shall be capable of handling the rated capacity of the alternator with no detrimental effect on any other

driven components. (See SBMTC; “School Bus Technical Reference,” for estimating required alternator capacity.)

5. A direct drive alternator is permissible in lieu of a belt driven alternator.

C. Wiring

1. All wiring shall conform to current applicable recommended practices of the Society of Automotive Engineers (SAE). All wiring shall use color and at least one other method of identification. The other method shall be either a number code or name code, and each chassis shall be delivered with a wiring diagram that illustrates the wiring of the chassis.
2. The chassis manufacturer shall install a readily accessible terminal strip or plug on the body side of the cowl or in an accessible location in the engine compartment of vehicles designed without a cowl. The strip or plug shall contain the following terminals for the body connections:
 - a. Main 100 amp body circuit;
 - b. Tail lamps;
 - c. Right turn signal;
 - d. Left turn signal;
 - e. Stop lamps;
 - f. Back-up lamps; and
 - g. Instrument panel lights (rheostat controlled by headlamp switch).

D. Circuits

1. An appropriate identifying diagram (color plus a name or number code) for all chassis electrical circuits shall be provided to the body manufacturer for distribution to the end user.
2. The headlight system must be wired separately from the body-controlled solenoid.

E. Daytime Running Lamps (DRL)

A Daytime Running Lamps system meeting chassis manufacturer's specifications may be provided.

ENGINE FIRE EXTINGUISHER

The chassis manufacturer may provide an automatic fire extinguisher system in the engine compartment.

EXHAUST SYSTEM

- A. The exhaust pipe, muffler and tailpipe shall be outside the bus body compartment and attached to the chassis so as not to damage any other chassis component.
- B. The tailpipe shall be constructed of a corrosion-resistant tubing material at least equal in strength and durability to 16-gauge steel tubing of equal diameter.
- C. Chassis manufacturers shall furnish an exhaust system with a tailpipe of sufficient length to exit the rear of the bus or at the left side of the bus body no more than 18 inches forward of the front edge of the rear wheel house opening. If designed to exit at the rear of the bus, the tailpipe shall extend at least five inches beyond the end of the chassis frame. If designed to exit to the side of the bus, the tailpipe shall extend at least 48.5 inches (51.5 inches if the body is to be 102 inches wide) outboard from the chassis centerline.
 - 1. On Types C and D vehicles, the tailpipe shall not exit beneath a fuel fill or emergency door exit.
 - 2. Types A and B chassis may be furnished with the manufacturer's standard tailpipe configuration.

(Note: See also Bus Body Standards: TAILPIPE.)

- D. The exhaust system on a chassis shall be adequately insulated from the fuel system.
- E. The muffler shall be constructed of corrosion-resistant material.
- F. The exhaust system on the chassis may be routed to the left of the right frame rail to allow for the installation of a power lift unit on the right side of the vehicle.

FENDERS: FRONT-TYPE C VEHICLES

- A. Total spread of outer edges of front fenders, measured at fender line, shall exceed the total spread of front tires when front wheels are in a straight-ahead position.
- B. Front fenders shall be properly braced and shall not require attachment to any part of the body.

FRAME

- A. The frame (or equivalent) shall be of such design and strength characteristics as to correspond at least to standard practices for trucks of the same general load characteristics which are used for highway service.
- B. Any secondary manufacturer that modifies the original chassis frame shall guarantee the performance of workmanship and materials resulting from such modification.
- C. Frames shall not be modified for the purpose of extending the wheel base.
- D. Holes in top or bottom flanges or side units of the frame, and welding to the frame, shall not be permitted except as provided or accepted by chassis manufacturer.
- E. Frame lengths shall be established in accordance with the design criteria for the complete vehicle.

FUEL TANK

- A. Fuel tank (or tanks) having a minimum 30-gallon capacity shall be provided by the chassis manufacturer. The tank shall be filled and vented to the outside of the body and the fuel filler should be placed in a location where accidental fuel spillage will not drip or drain on any part of the exhaust system.
- B. Fuel lines shall be mounted to the chassis frame in such a manner that the frame provides the maximum possible protections from damage.
- C. The fuel system shall comply with FMVSS No. 301.
- D. Fuel tank(s) may be mounted between the chassis frame rails or outboard of the frame rails on either the left or right side of the vehicle.
- E. The actual draw capacity of each fuel tank shall be a minimum of 83 percent of the tank capacity.

- F. Installation of alternative fuel systems, including fuel tanks and piping from tank to the engine, shall comply with all applicable fire codes in effect on the date of manufacture of the bus.

Installation of LPG tanks shall comply with National Fire Protection Association (NFPA) 58.

GOVERNOR

When the engine is remotely located from the driver, the governor shall be set to limit engine speed to maximum revolutions per minute as recommended by the engine manufacturer, and a tachometer shall be installed so the engine speed may be known to the driver while seated in a normal driving position.

HEATING SYSTEM, PROVISION FOR

The chassis engine shall have plugged openings for the purpose of supplying hot water for the bus heating system. The openings shall be suitable for attaching 3/4 inch pipe thread/hose connectors. The engine shall be capable of supplying coolant at a temperature of at least 170 degrees Fahrenheit at the engine cooling thermostat opening temperature. The coolant flow rate shall be 50 pounds per minute at the return end of 30 feet of one-inch inside diameter automotive hot water heater hose. (See SBMT C-001.)

HORN

The bus shall be equipped with a horn(s) of standard make with each horn capable of producing a complex sound in bands of audio frequencies between 250 and 2,000 cycles per second and tested in accordance with SAE J-377.

INSTRUMENTS AND INSTRUMENT PANEL

- A. The chassis shall be equipped with the instruments and gauges listed below. (Telltale warning lamps in lieu of gauges are not acceptable, except as noted.)

1. Speedometer;
2. Odometer which will give accrued mileage (to seven digits), including tenths of miles;
3. Voltmeter;

(An ammeter with graduated charge and discharge indications is permitted in lieu of a voltmeter; however, when used, the ammeter wiring must be compatible with the current flow of the system.)

4. Oil pressure gauge;
5. Water temperature gauge;
6. Fuel gauge;
7. Upper beam headlamp indicator;
8. Brake indicator gauge (vacuum or air);

(A telltale warning lamp indicator in lieu of a gauge is permitted on a vehicle equipped with a hydraulic-over-hydraulic brake system.)

9. Turn signal indicator; and
10. Glow-plug indicator light where appropriate.

B. All instruments shall be easily accessible for maintenance and repair.

C. The instruments and gauges shall be mounted on the instrument panel so that each is clearly visible to the driver while seated in a normal driving position.

D. The instrument panel shall have lamps of sufficient candlepower to illuminate all instruments, gauges and shift selector indicator for the automatic transmission.

E. Multi-function gauge (MFG) (optional)

1. The driver must be able to manually select any displayable function of the gauge on a MFG whenever desired.
2. Whenever an out-of-limits condition that would be displayed on one or more functions of a MFG occurs, the MFG controller should automatically display this condition on the instrument cluster. This should be in the form of an illuminated telltale warning lamp as well as having the MFG automatically display the out-of-limits indications. Should two or more functions displayed on the MFG go out of limits simultaneously, then the MFG should sequence automatically between those functions continuously until the condition(s) are corrected.
3. The use of a MFG does not relieve the need for audible warning devices, where required.

OIL FILTER

An oil filter with a replaceable element shall be provided and connected by flexible oil lines if it is not a built-in or an engine-mounted design. The oil filter shall have a capacity of at least one (1) quart.

OPENINGS

All openings in the floorboard or firewall between chassis and the passenger compartment (e.g., for gearshift selector and parking brakes lever) shall be sealed.

PASSENGER LOAD

- A. Actual gross vehicle weight (GVW) is the sum of the chassis weight plus the body weight, plus the driver's weight, plus total seated pupil weight.

For purposes of calculation, the driver's weight is 150 pounds and the pupil weight is 120 pounds per pupil.

- B. Actual GVW shall not exceed the chassis manufacturer's GVWR for the chassis, nor shall the actual weight carried on any axle exceed the chassis manufacturer's Gross Axle Weight Rating (GAWR.)

POWER AND GRADE ABILITY

GVWR shall not exceed 185 pounds per published net horsepower of the engine at the manufacturer's recommended maximum number of revolutions per minute.

RETARDER SYSTEM (OPTIONAL EQUIPMENT)

A retarder system, if used, shall maintain the speed of a fully loaded school bus at 19.0 mph on a seven percent grade for 3.6 miles.

ROAD SPEED CONTROL

When it is desired to accurately control vehicle maximum speed, a vehicle speed limiter may be utilized.

SHOCK ABSORBERS

The bus shall be equipped with double-action shock absorbers compatible with manufacturer's rated axle capacity at each wheel location.

STEERING GEAR

- A. The steering gear shall be approved by the chassis manufacturer and designed to ensure safe and accurate performance when the vehicle is operated with maximum load and at maximum speed.
- B. If external adjustments are required, steering mechanism shall be accessible to make adjustments.
- C. No changes shall be made in the steering apparatus which are not approved by the chassis manufacturer.
- D. There shall be a clearance of at least two inches between the steering wheel and cowl, instrument panel, windshield, or any other surface.
- E. Power steering is required and shall be of the integral type with integral valves.
- F. The steering system shall be designed to provide a means for lubrication of all wear-points, which are not permanently lubricated.

SUSPENSION SYSTEMS

- A. The capacity of springs or suspension assemblies shall be commensurate with the chassis manufacturer's GVWR .
- B. Steel leaf rear springs shall be of a progressive rate or multi-stage design. Front leaf springs shall have a stationary eye at one end and shall be protected by a wrapped leaf, in addition to the main leaf.

THROTTLE

The force required to operate the throttle shall not exceed 16 pounds throughout the full range of accelerator pedal travel.

TIRES AND RIMS

- A. Rims of the proper size and tires of the proper size and load rating commensurate with the chassis manufacturer's gross vehicle weight rating shall be provided. The use of multi-piece rims and/or tube-type tires shall not be permitted on any school bus with a "build date" after June 30, 1997.
- B. Dual rear tires shall be provided on Type A-2, Type B, Type C and Type D school buses.

- C. All tires on a vehicle shall be of the same size, and the load range of the tires shall meet or exceed the GVWR, as required by FMVSS No. 120.
- D. If the vehicle is equipped with a spare tire and rim assembly, it shall be the same size as those mounted on the vehicle.
- E. If a tire carrier is required, it shall be suitably mounted in an accessible location outside the passenger compartment.

TRANSMISSION

- A. Automatic transmissions shall have no fewer than three forward speeds and one reverse speed. Mechanical shift selectors shall provide a detent between each gear position when the gear selector quadrant and shift selector are not steering-column mounted.
- B. In manual transmissions, second gear and higher shall be synchronized, except when incompatible with engine power. A minimum of three forward speeds and one reverse speed shall be provided.
- C. An electronic control, or similar device, may be installed to ensure that automatic transmissions cannot accidentally be moved out of the “neutral” or “park” gear position while the driver is not seated in the driver’s seat.

TURNING RADIUS

- A. A chassis with a wheelbase of 264 inches or less shall have a right and left turning radius of not more than 42 1/2 feet, curb-to-curb measurement.
- B. A chassis with a wheelbase of 265 inches or more shall have a right and left turning radius of not more than 44 1/2 feet, curb-to-curb measurement.

UNDERCOATING

The chassis manufacturers, or their agents, shall coat the undersides of steel or metallic-constructed front fenders with a rust-proofing compound, for which the compound manufacturer has issued notarized certification of compliance to chassis builder that the compound meets or exceeds all performance and qualitative requirements of paragraph 3.4 of Federal Specification TT-C-520B, using modified tests.

BUS BODY SPECIFICATIONS

AISLE

- A. All emergency doors shall be accessible by a 12-inch minimum aisle. The aisle shall be unobstructed at all times by any type of barrier, seat, wheelchair or tiedown, unless a flip seat is installed and occupied. A flip seat in the unoccupied (up) position shall not obstruct the 12-inch minimum aisle to any side emergency door.
- B. The seat backs shall be slanted sufficiently to give aisle clearance of 15 inches at tops of seat backs.

BACK-UP WARNING ALARM

An automatic audible alarm shall be installed behind the rear axle and shall comply with the published Backup Alarm Standards (SAE J994B), providing a minimum of 112 dbA.

BATTERY

- A. The battery is to be furnished by the chassis manufacturer.
- B. When the battery is mounted as described in the “Bus Chassis Specifications,” the body manufacturer shall securely attach the battery on a slide-out or swing-out tray in a closed, vented compartment in the body skirt, so that the battery is accessible for convenient servicing from the outside. The battery compartment door or cover shall be hinged at the front or top, and be secured by an adequate and conveniently operated latch or other type fastener. The battery compartment is not required on Type A buses.
- C. Buses may be equipped with a battery shut-off switch. The switch is to be placed in a location not readily accessible to the driver or passengers.

BUMPER: FRONT

On a Type D school bus, if the chassis manufacturer does not provide a bumper, it shall be provided by the body manufacturer. The bumper will conform to the standards described in the “Bus Chassis Specifications.”

BUMPER: REAR

- A. The bumper shall be pressed steel channel at least 3/16 inch thick or equivalent strength material (except for Type A buses). Type A-1 buses bumper shall be a minimum of 8 inches wide (high) and Type A-2, B, C

and D buses bumper shall be a minimum of 9 1/2 inches wide (high). The bumper shall be of sufficient strength to permit being pushed by another vehicle without permanent distortion.

- B. The bumper shall be wrapped around the back corners of the bus. It shall extend forward at least 12 inches, measured from the rear-most point of the body at the floor line, and shall be flush-mounted to the body sides or protected with an end panel.
- C. The bumper shall be attached to the chassis frame in such a manner that it may be easily removed. It shall be so braced as to withstand impact from the rear or the side. It shall be so attached as to discourage hitching of rides by an individual.
- D. The bumper shall extend at least 1 inch beyond the rear-most part of the body surface measured at the floor line.

CEILING

See Insulation and Interior, this section.

CERTIFICATION

The body manufacturer shall, upon request of the Missouri Department of Elementary and Secondary Education, certify that its product meets the state's minimum standards on items which are not covered by FMVSS certification requirements of 49 CFR, Part 567.

CHAINS (TIRE)

See Wheelhousing, this section.

COLOR

- A. The school bus body shall be painted National School Bus Yellow (NSBY). (See Appendix B).
- B. The body exterior paint trim shall be black.
- C. Optionally, the roof of the bus may be painted white except that the front and rear roof caps shall remain NSBY. (See illustration in Appendix B, under Reflective Materials.)

CONSTRUCTION

- A. **Side Intrusion Test:** The bus body shall be constructed to withstand an intrusion force equal to the curb weight of the vehicle; but shall not exceed 20,000 pounds, whichever is less. Each vehicle shall be capable of meeting this requirement when tested in accordance with the procedures set forth below.

The complete body structure, or a representative seven-body section mock up with seats installed, shall be load-tested at a location 24 inches plus or minus two inches above the floor line, with a maximum 10-inch diameter cylinder, 48 inches long, mounted in a horizontal plane.

The cylinder shall be placed as close as practical to the mid-point of the tested structure, spanning two internal vertical structural members. The cylinder shall be statically loaded to the required force of curb weight or 20,000 pounds, whichever is less, in a horizontal plane with the load applied from the exterior toward the interior of the test structure. Once the minimum load has been applied, the penetration of the loading cylinder into the passenger compartment shall not exceed a maximum of ten inches from its original point of contact. There can be no separation of lapped panels or construction joints. Punctures, tears or breaks in the external panels are acceptable but are not permitted on any adjacent interior panel.

Body companies shall certify compliance with this intrusion requirement, including test results, if requested.

- B. Construction shall be reasonably dust-proof and watertight.

CROSSING CONTROL ARM

- A. Every school bus operated to transport students in the public school system which has a gross vehicle weight rating of more than ten thousand pounds, which has the engine mounted entirely in front of the windshield and the entrance door behind the front wheels, and which is used for the transportation of school children shall be equipped with a crossing control arm. The crossing control arm, when activated, shall extend a minimum of five feet six inches from the face of the front bumper. The crossing control arm shall be attached on the right side of the front bumper and shall be activated by the same controls which activate the mechanical and electrical signaling devices approved by the state board of education, which will display a signal plainly visible from the front and rear indicating intention to stop. All crossing control arms installed as optional equipment on other types of school buses must comply with the specifications and requirements of this section.

- B. The crossing control arm when opened shall extend in a line parallel with the body side and positioned on a line with the right side wheels.
- C. All components of the crossing control arm and all connections shall be weatherproofed.
- D. The crossing control arm shall incorporate system connectors (electrical, vacuum or air) at the gate and shall be easily removable to allow for towing of the bus.
- E. The crossing control arm shall meet or exceed SAE J1133.
- F. The crossing control arm shall be constructed of noncorrosive or nonferrous material or treated in accordance with the body sheet metal specification. (see METAL TREATMENT.)
- G. There shall be no sharp edges or projections that could cause hazard or injury to students.
- H. The crossing control arm shall extend simultaneously with the stop arm(s) by means of the stop arm controls.
- I. An automatic recycling interrupt switch should be installed for temporary disabling of the crossing control arm.

DEFROSTERS

- A. Defrosting and defogging equipment shall direct a sufficient flow of heated air onto the windshield, the window to the left of the driver and the glass in the viewing area directly to the right of the driver to eliminate frost, fog and snow.
- B. The defrosting system shall conform to SAE J381 and J382.
- C. The defroster and defogging system shall be capable of furnishing heated, outside ambient air, except that the part of the system furnishing additional air to the windshield, entrance door and stepwell may be of the recirculating air type.
- D. Auxiliary fans are not considered defrosting or defogging systems.
- E. Portable heaters shall not be used.

DOORS

A. Service door

1. The service door shall be in the driver's control, designed to afford easy release and to provide a positive latching device on manual operating doors to prevent accidental opening. When a hand lever is used, no part shall come together that will shear or crush fingers. Manual door controls shall not require more than 25 pounds of force to operate at any point throughout the range of operation, as tested on a 10 percent grade both uphill and downhill.
2. The service door shall be located on the right side of the bus, opposite and within direct view of driver.
3. The service door shall have a minimum horizontal opening of 24 inches and a minimum vertical opening of 68 inches. Type A-1 vehicles shall have a minimum opening area of 1,200 square inches.
4. Service door shall be a split-type, sedan-type or jackknife-type. (Split-type door includes any sectioned door which divides and opens inward or outward.) If one section of a split-type door opens inward and the other opens outward, the front section shall open out-ward.
5. Lower, as well as upper, door panels shall be of approved safety glass. The bottom of each lower glass panel shall not be more than ten inches from the top surface of the bottom step. The top of each upper glass panel shall not be more than three inches from the top of the door. Type A vehicles shall have an upper panel (windows) of safety glass with an area of at least 350 square inches.
6. Vertical closing edges on split-type or folding-type entrance doors shall be equipped with flexible material to protect children's fingers. Type A-1 vehicles may be equipped with the chassis manufacturer's standard entrance door.
7. There shall be no door to the left of the driver on Type B, C or D vehicles. All Type A vehicles may be equipped with the chassis manufacturer's standard left-side door.
8. All doors shall be equipped with padding at the top edge of each door opening. Padding shall be at least three inches wide and one-inch thick and extend the full width of the door opening.

9. If equipped with power-operated service doors, the emergency release valve, switch or device to release the service door must be placed above or to the immediate left or right of the service door and clearly labeled.

EMERGENCY EXITS

- A. All installed emergency exits shall comply with the requirements of FMVSS No. 217.
- B. Emergency door requirements
 1. The upper portion of the emergency door shall be equipped with approved safety glazing, the exposed area of which shall be at least 400 square inches. The lower portion of the rear emergency doors on Types A, B, C, and D vehicles shall be equipped with a minimum of 350 square inches of approved safety glazing.
 2. There shall be no steps leading to an emergency door.
 3. The emergency door(s) shall be equipped with padding at the top edge of each door opening. Padding shall be at least three inches wide and one-inch thick, and shall extend the full width of the door opening.
 4. There shall be no obstruction higher than 1/4 inch across the bottom of any emergency door opening.
 5. The rear emergency window shall have an assisted lifting device that will aid in lifting and holding the rear emergency window open.
 6. The words "EMERGENCY DOOR", in letters at least 2" high, shall be placed at the top of or directly above the emergency door, or on the door in the metal panel above the top glass, both inside and outside the bus.
 7. A lock may be placed on the emergency door only if the engine starting and operating system will not function if the emergency door is locked from either inside or outside the bus.
- C. Emergency exit requirements

Types A, B, C, and D vehicles shall be equipped with a total minimum number of emergency exits as follows for the indicated capacities of

vehicles. Exits required by FMVSS 217 may be included to comprise the total number of exits specified.

0 to 42 Passengers	=1 emergency exit per side and 1 roof hatch.
43 to 78 Passengers	=2 emergency exits per side and 2 roof hatches.
79 to 90 Passengers	= 3 emergency exits per side and 2 roof hatches.

Side emergency exit windows when installed may be vertically hinged on the forward side of the window. No side emergency exit window will be located above a stop arm.

In addition to the audible warning required on emergency doors by FMVSS 217, additional emergency exits shall also be equipped with an audible warning device.

EMERGENCY EQUIPMENT

A. Fire extinguisher

1. The bus shall be equipped with at least one UL-approved pressurized, dry chemical fire extinguisher complete with hose. The extinguisher shall be mounted (and secured) in a bracket, located in the driver's compartment and readily accessible to the driver and passengers. A pressure gauge shall be mounted on the extinguisher and shall be easily read without moving the extinguisher from its mounted position.
2. The fire extinguisher shall have a total rating of 2A10BC or greater. The operating mechanism shall be sealed with a type of seal that will not interfere with the use of the fire extinguisher.

B. First-aid kit

1. The bus shall have a removable, moisture-proof and dust-proof first aid kit in an accessible place in the driver's compartment. It shall be properly mounted (and secured) and identified as a first aid kit. The location for the first aid kit shall be marked.
2. Suggested contents include:
 - 2 - 1 inch x 2 1/2 yards of adhesive tape rolls
 - 24 - sterile gauze pads 3 inches x 3 inches
 - 100 - 3/4 inch x 3 inches adhesive bandages
 - 8 - 2 inch bandage compress

- 10 - 3 inch bandage compress
- 2 - 2 inch x 6 feet sterile gauze roller bandages
- 2 - non-sterile triangular bandages minimum 39 inches x 35 inches x 54 inches with 2 safety pins
- 3 - sterile gauze pads 36 inches x 36 inches
- 3 - sterile eye pads
- 1 - rounded-end scissors
- 1 - pair medical examination gloves
- 1 - mouth-to-mouth airway

C. Body fluid clean-up kit

1. Each bus shall have a removable and moisture-proof body fluid clean-up kit accessible to the driver. It shall be properly mounted and identified as a body fluid clean-up kit.
2. Suggested contents include:
 - 1 – 2 oz. Infectious liquids spill control powder
 - 1 – odor mask
 - 1 – pair latex gloves
 - 4 – antiseptic wipes
 - 2 – paper crepe towels
 - 1 – plastic scraper
 - 1 – plastic disposal bag with scoop and tie
 - 1 – other OSHA required Bloodborne Pathogen protection, i.e. protection gown & cap, goggle, red bio-hazard bags w/ties, special decal red w/black print
 - 1 – printed instructions for use of kit contents

D. Warning devices

Each school bus shall contain at least three reflectorized triangle road warning devices mounted in an accessible place that meet requirements in FMVSS No. 125.

- E. Any of the emergency equipment may be mounted in an enclosed compartment, provided the compartment is labeled in not less than one-inch letters, identifying each piece of equipment contained therein.

FLOORS

- A. The floor in the under-seat area, including tops of wheel housings, driver's compartment and toeboard, shall be covered with rubber floor covering or equivalent, having a minimum overall thickness of .125 inch. The driver's

area in all Type A buses may be manufacturer's standard flooring and floor covering.

- B. The floor covering in the aisles shall be of aisle-type rubber or equivalent, wear-resistant and ribbed. Minimum overall thickness shall be .187 inch measured from tops of ribs.
- C. The floor covering must be permanently bonded to the floor and must not crack when subjected to sudden changes in temperature. Bonding or adhesive material shall be waterproof and shall be a type recommended by the manufacturer of floor-covering material. All seams must be sealed with waterproof sealer.
- D. On Types B, C and D buses, a flush-mounted, screw-down plate that is secured and sealed shall be provided to access the fuel tank sending unit.

HANDRAILS

At least one handrail shall be installed. The handrail(s) shall assist passengers during entry or exit, and be designed to prevent entanglement, as evidenced by the passage of the NHTSA string and nut test.

HEATING AND AIR CONDITIONING SYSTEMS

- A. Heating System
 - 1. The heater shall be hot water and/or combustion type.
 - 2. If only one heater is used, it shall be fresh-air or combination fresh-air and recirculation type.
 - 3. If more than one heater is used, additional heaters may be recirculating air type.
 - 4. The heating system shall be capable of maintaining bus interior temperatures as specified in SAE test procedure J2233.
 - 5. Auxiliary fuel-fired heating systems are permitted, provided they comply with the following:
 - a. The auxiliary heating system fuel shall utilize the same type fuel as specified for the vehicle engine;
 - b. The heater(s) may be direct hot air or connected to the engine's coolant system;

- c. An auxiliary heating system, when connected to the engine's coolant system, may be used to preheat the engine coolant or preheat and add supplementary heat to the bus's heating system;
 - d. Auxiliary heating systems must be installed pursuant to the manufacturer's recommendations and shall not direct exhaust in such a manner that will endanger bus passengers;
 - e. Auxiliary heating systems which operate on diesel fuel shall be capable of operating on #1, #2 or blended diesel fuel without the need for system adjustment;
 - f. The auxiliary heating system shall be low voltage;
 - g. Auxiliary heating systems shall comply with all applicable FMVSSs, including FMVSS No. 301, as well as with SAE test procedures.
6. All forced air heaters installed by body manufacturers shall bear a nameplate that indicates the heater rating in accordance with SBMTC-001. The plate shall be affixed by the heater manufacturer and shall constitute certification that the heater performance is as shown on the plate.
 7. Heater hoses shall be adequately supported to guard against excessive wear due to vibration. The hoses shall not dangle or rub against the chassis or any sharp edges and shall not interfere with or restrict the operation of any engine function. Heater hoses shall conform to SAE J20c. Heater lines on the interior of bus shall be shielded to prevent scalding of the driver or passengers.
 8. Each hot water system installed by a body manufacturer shall include one shut-off valve in the pressure line and one shut-off valve in the return line with both valves at the engine in an accessible location, except that on all Types A and B buses, the valves may be installed in another accessible location.
 9. There shall be a water-flow regulating valve installed in the pressure line for convenient operation by the driver while seated.
 10. All combustion heaters shall be in compliance with current Federal Motor Carrier Safety Regulations.

11. Accessible bleeder valves shall be installed in an appropriate place in the return lines of body company-installed heaters to remove air from the heater lines.
12. Access panels shall be provided to make heater motors, cores and fans readily accessible for service. An outside access panel may be provided for the driver's heater.

B. Air Conditioning (Optional)

The following requirements are applicable to all types of school buses that may be equipped with air conditioning.

1. Requirements

The installed air conditioning system should cool the interior of the bus down to at least 80 degrees Fahrenheit, measured at a minimum of three points, located four feet above the floor at the longitudinal centerline of the bus. The three points shall be: (1) near the driver's location, (2) at the mid point of the body, and (3) two feet forward of the emergency door, or, for Type D rear-engine buses, two feet forward of the end of the aisle.

The test conditions under which the above performance must be achieved shall consist of: (1) placing the bus in a room (such as a paint booth) where ambient temperature can be maintained at 100 degrees Fahrenheit, (2) heat soaking the bus at 100 degrees Fahrenheit with windows open for at least one hour, and (3) closing windows, turning on the air conditioner with the engine running at the chassis manufacturer's recommended low idle speed, and cooling the interior of the bus to 80 degrees Fahrenheit or lower within a maximum of 30 minutes while maintaining 100 degrees Fahrenheit outside temperature.

Alternately, and at the user's discretion, this test may be performed under actual summer conditions, which consist of temperatures above 85 degrees Fahrenheit, humidity above 50 percent with normal sun loading of the bus and the engine running at the engine manufacturer's recommended low idle speed. After a minimum of one hour of heat soaking, the system shall be turned on and must provide a minimum 20 degree temperature drop in the 30-minute time limit. The manufacturer shall provide facilities for the user or user's representative to confirm that a pilot model of each bus design meets the above performance requirements.

2. Other Requirements

- a. Evaporator cases, lines and ducting (as equipped) shall be designed in such a manner that all condensation is effectively drained to the exterior of the bus below the floor level under all conditions of vehicle movement and without leakage on any interior portion of bus.
- b. Any evaporator or ducting system shall be designed and installed so as to be free of injury-prone projections or sharp edges. Any ductwork shall be installed so that exposed edges face the front of the bus and do not present sharp edges.
- c. On specially equipped school buses, the evaporator and ducting (if used) shall be placed high enough that they will not obstruct occupant securement shoulder strap upper attachment points. This clearance shall be provided along entire length of the passenger area on both sides of the bus interior to allow for potential retrofitting of new wheelchair positions and occupant securement devices throughout the bus.
- d. The body may be equipped with insulation, including sidewalls, roof, firewall, rear, inside body bows and plywood or composite floor insulation to aid in heat dissipation and reflection.
- e. All glass (windshield, service and emergency doors, side and rear windows) may be equipped with maximum integral tinting allowed by federal, state or ANSI standards for the respective locations, except that windows rear of the driver's compartment, if tinted, shall have approximately 28 percent light transmission.
- f. Electrical generating capacity shall be provided to accommodate the additional electrical demands imposed by the air conditioning system.
- g. Roofs may be painted white to aid in heat dissipation. (See Appendix B)

HINGES

All exterior metal door hinges which do not have stainless steel, brass or nonmetallic hinge pins or other designs that prevent corrosion shall be designed to

allow lubrication to be channeled to the center 75 percent of each hinge loop without disassembly.

IDENTIFICATION

- A. The body shall bear the words “SCHOOL BUS” in black letters at least eight inches high on both front and rear of the body or on signs attached thereto. Lettering shall be placed as high as possible without impairment of its visibility. Letters shall conform to “Series B” of Standard Alphabets for Highway Signs. “SCHOOL BUS” lettering shall have a reflective background, or as an option, may be illuminated by backlighting.
- B. Required lettering and numbering shall include:
 - 1. The bus identification number displayed on the sides, on the rear, and on the front.
- C. Other lettering, numbering or symbols which may be displayed on the exterior of the bus shall be limited to:
 - 1. Bus identification number on the top of the bus, in addition to required numbering on the sides, rear, and front;
 - 2. The location of the battery(ies) identified by the word “BATTERY” or “BATTERIES” on the battery compartment door in two-inch lettering;
 - 3. Symbols or letters not to exceed 413 square inches of total display near the service door, displaying information for identification by the students of the bus or route served;
 - 4. Manufacturer, dealer or school identification or logos;
 - 5. Symbols identifying the bus as equipped for or transporting students with special needs (See Specially Equipped School Bus section);
 - 6. Identification of fuel type in two-inch lettering adjacent to the fuel filler opening.
 - 7. Each bus shall have lettered on the rear in plain and distinct black letters: “STATE LAW—STOP—While Bus is Loading and Unloading.” The letters in the words “STATE LAW—STOP” shall not be less than 5” in height and letters in the words “While Bus is Loading and Unloading” not less than 3” in height.

8. There shall be displayed on each side of a district owned bus the school district name in black letters not less than 3" in height with a stroke of not less than 3/8" wide. If such lettering is placed on the sides of contracted vehicles, lettering shall be black.
 9. Privately-owned school buses shall display, on each side in a conspicuous location, the name and address of the owner in black letters at least 2" in height with a stroke of not less than 1/4" in width.
- D. Lettering or signs indicating no trespassing may be located on the inside of a school bus.

INSIDE HEIGHT

Inside body height shall be 72 inches or more, measured metal to metal, at any point on longitudinal centerline from front vertical bow to rear vertical bow.

Inside body height of Type A-1 buses shall be 62 inches or more.

INSULATION

- A. Ceiling and walls shall be insulated with proper material to deaden sound and to reduce vibration to a minimum.
- B. If thermal insulation is specified, it shall be fire-resistant, UL approved, with minimum R-value of 5.5. Insulation shall be installed so as to prevent sagging.
- C. If floor insulation is required, it shall be five ply nominal 5/8 inch-thick plywood, and it shall equal or exceed properties of the exterior-type softwood plywood, C-D Grade, as specified in the standard issued by U.S. Department of Commerce. When plywood is used, all exposed edges shall be sealed. Type A buses may be equipped with nominal 1/2 inch-thick plywood or equivalent material meeting the above requirements. Equivalent material may be used to replace plywood, provided it has an equal or greater insulation R value, deterioration, sound abatement and moisture resistance properties.

INTERIOR

- A. The interior of bus shall be free of all unnecessary projections, which include luggage racks and attendant handrails, to minimize the potential for injury. This specification requires inner lining on ceilings and walls. If the ceiling is constructed to contain lap joints, the forward panel shall be lapped by rear panel and exposed edges shall be beaded, hemmed, flanged or otherwise treated to minimize sharp edges. Buses may be equipped

with a storage compartment for tools, tire chains and/or tow chains. (see STORAGE COMPARTMENT.)

- B. Interior overhead storage compartments may be provided if they meet the following criteria:
 - 1. Meet head protection requirements of FMVSS No. 222, where applicable;
 - 2. Have a maximum rated capacity displayed for each compartment;
 - 3. Be completely enclosed and equipped with latching doors which must be sufficient to withstand a force of five times the maximum rated capacity of the compartment;
 - 4. Have all corners and edges rounded with a minimum radius of one-inch or padded equivalent to door header padding;
 - 5. Be attached to the bus sufficiently to withstand a force equal to twenty times the maximum rated capacity of the compartment; and
 - 6. Have no protrusions greater than 1/4 inch.
- C. The driver's area forward of the foremost padded barriers will permit the mounting of required safety equipment and vehicle operation equipment.
- D. Every school bus shall be constructed so that the noise level taken at the ear of the occupant nearest to the primary vehicle noise source shall not exceed 85 dbA when tested according to the procedure in Appendix B.

LAMPS AND SIGNALS

- A. Interior lamps shall be provided which adequately illuminate the aisle and the stepwell. The stepwell light shall be illuminated by a service door-operated switch, to illuminate only when headlights and clearance lights are on and the service door is open.
- B. Body instrument panel lights shall be controlled by an independent rheostat switch.
- C. School bus alternately flashing signal lamps
 - 1. The bus shall be equipped with two red lamps at the rear of the vehicle and two red lamps at the front of the vehicle.

2. In addition to the four red lamps described above, four amber lamps shall be installed so that one amber lamp is located near each red signal lamp, at the same level, but closer to the vertical centerline of bus. The system of red and amber signal lamps shall be wired so that amber lamps are energized manually, and red lamps are automatically energized (with amber lamps being automatically de-energized) when stop signal arm is extended or when bus service door is opened. An amber pilot light and a red pilot light shall be installed adjacent to the driver controls for the flashing signal lamp to indicate to the driver which lamp system is activated.
3. The area around the lenses of alternately flashing signal lamps extending outward from the edge of the lamps three inches (+/- 1/4 inch) to the sides and top and minimum one-inch to the bottom, shall be black in color on the body or roof area against which the signal lamp is seen (from distance of 500 feet along axis of the vehicle). Visors or hoods, black in color, with a minimum depth of four inches may be provided. (See also Appendix B.)
4. Red lamps shall flash at any time the stop signal arm is extended.
5. All flashers for alternately flashing red and amber signal lamps shall be enclosed in the body in a readily accessible location.

D. Turn signal and stop/tail lamps

1. Bus body shall be equipped with amber rear turn signal lamps that are at least seven inches in diameter or, if a shape other than round, a minimum 38 square inches of illuminated area and shall meet SAE specifications. These signal lamps must be connected to the chassis hazard warning switch to cause simultaneous flashing of turn signal lamps when needed as a vehicular traffic hazard warning. Turn signal lamps are to be placed as wide apart as practical and their centerline shall be a maximum of 12 inches below the rear window. Type A-1 conversion vehicle lamps must be at least 21 square inches in lens area and must be in the manufacturer's standard color.
2. Buses shall be equipped with amber side-mounted turn signal lights. The turn signal lamp on the left side shall be mounted rearward of the stop signal arm and the turn signal lamp on the right side shall be mounted rearward of the service door.
3. If turn signal lamps in addition to those supplied on chassis are provided (front of body below windshield or top of fender), they

shall be connected to turn signal system without removal or disconnection of turn signal lamps supplied on chassis.

4. Buses shall be equipped with four combination red stop/tail lamps.

- a. Two combination lamps with a minimum diameter of seven inches, or if a shape other than round, a minimum 38 square inches of illuminated area shall be mounted on the rear of the bus just inside the turn signal lamps.
- b. Two combination lamps with a minimum diameter of four inches, or if a shape other than round, a minimum of 12 square inches of illuminated area, shall be placed on the rear of the body between the beltline and the floor line. The rear license plate lamp may be combined with one lower tail lamp. Stop lamps shall be activated by the service brakes and shall emit a steady light when illuminated. Type A-1 buses with bodies supplied by chassis manufacturer may be equipped with manufacturer's standard stop and tail lamps.

- E. On buses equipped with a monitor for the front and rear lamps of the school bus, the monitor shall be mounted in full view of the driver. If the full circuit current passes through the monitor, each circuit shall be protected by a fuse or circuit breaker against any short circuit or intermittent shorts.
- F. An optional white flashing strobe light may be installed on the roof of a school bus, at a location not to exceed 1/3 the body length forward from the rear of the roof edge. The light shall have a single clear lens emitting light 360 degrees around its vertical axis and may not extend above the roof more than maximum legal height. A manual switch and a pilot light shall be included to indicate when the light is in operation. Optionally, the strobe light may be mounted on the roof in the area directly over the restraining barrier on the driver's side, may be wired to activate with the amber alternately flashing signal lamps, continuing through the full loading or unloading cycle, and may be equipped with an override switch to allow activation of the strobe at any time.
- G. The bus body shall be equipped with two white rear backup lamp signals that are at least four-inches in diameter or, if a shape other than round, a minimum of 13 square inches of illuminated area, meeting FMVSS No. 108. If backup lamps are placed on the same horizontal line as the brake lamps and turn signal lamps, they shall be to the inside.

METAL TREATMENT

- A. All metal used in construction of the bus body shall be zinc-coated or aluminum-coated or treated by an equivalent process before the bus is constructed. Included are such items as structural members, inside and outside panels, door panels and floor sills. Excluded are such items as door handles, grab handles, interior decorative parts and other interior plated parts.
- B. All metal parts that will be painted, in addition to the above requirements, shall be chemically cleaned, etched, zinc phosphate-coated and zinc chromate-or epoxy-primed, or the metal may be conditioned by equivalent process.
- C. In providing for these requirements, particular attention shall be given to lapped surfaces, welded connections of structural members, cut edges on punched or drilled hole areas in sheet metal, closed or box sections, unvented or undrained areas and surfaces subjected to abrasion during vehicle operation.
- D. As evidence that the above requirements have been met, samples of materials and sections used in the construction of the bus body shall not lose more than 10 percent of material by weight when subjected to a 1,000-hour salt spray test as provided for in the latest revision of ASTM Standard B-117.

MIRRORS

- A. The interior mirror shall be either clear view laminated glass or clear view glass bonded to a backing which retains the glass in the event of breakage. The mirror shall have rounded corners and protected edges. All Type A buses shall have a minimum of a 6-inch x 16-inch mirror and Types B, C and D buses shall have a minimum of a 6-inch x 30-inch mirror.
- B. Each school bus shall be equipped with exterior mirrors meeting the requirements of FMVSS No. 111. Mirrors shall be easily adjustable but shall be rigidly braced so as to reduce vibration.
- C. Heated external mirrors may be used.

MOUNTING

- A. The chassis frame shall support the rear body cross member. The bus body shall be attached to chassis frame at each main floor sill, except where chassis components interfere, in such a manner as to prevent

shifting or separation of the body from the chassis under severe operating conditions.

- B. Isolators shall be installed at all contact points between the body and the chassis frame on Types A-2, B, C and D buses, and shall be secured by a positive means to the chassis frame or body to prevent shifting, separation, or displacement of the isolators under severe operating conditions.

OVERALL LENGTH

Overall length of the bus shall not exceed 45 feet, excluding accessories.

OVERALL WIDTH

Overall width of bus shall not exceed 102 inches, excluding accessories.

POST TRIP SAFETY ALARM (Optional)

It is recommended that a post trip safety alarm be installed to assure no children will be left on a school bus. The post trip safety alarm system requires the driver to walk to the rear of the bus checking for children, and to be able to disarm the alarm.

- A. The post trip safety alarm system shall become activated when the engine or electrical system has been turned off.
- B. The system shall have a driver alert notification mechanism.
- C. The system shall have a switch located in the rear of the bus accessible by the driver.

PUBLIC ADDRESS SYSTEM

- A. Buses may be equipped with an AM/FM/audio and/or public address system having interior and exterior speakers.
- B. No internal speakers, other than the driver's communication systems, may be installed within four feet of the driver's seat back in its rearmost upright position.

REFLECTIVE MATERIAL (see also Reflective Material, Appendix B.)

- A. The front and/or rear bumper may be marked diagonally 45 degrees down to centerline of pavement with two-inch $\pm 1/4$ inch wide strips of non-contrasting reflective material.

- B. The rear of bus body shall be marked with strips of reflective NSBY material to outline the perimeter of the back of the bus using material which conforms with the requirements of FMVSS No. 131, Table 1. The perimeter marking of rear emergency exits per FMVSS No. 217 and/or the use of reflective “SCHOOL BUS” signs partially accomplishes the objective of this requirement. To complete the perimeter marking of the back of the bus, strips of at least one 3/4-inch-reflective NSBY material shall be applied horizontally above the rear windows and above the rear bumper, extending from the rear emergency exit perimeter, marking outward to the left and right rear corners of the bus. Vertical strips shall be applied at the corners connecting these horizontal strips.
- C. “SCHOOL BUS” signs, if not of lighted design, shall be marked with reflective NSBY material comprising background for lettering of the front and/or rear “SCHOOL BUS” signs.
- D. Sides of bus body shall be marked with at least one 3/4-inch-reflective NSBY material, extending the length of the bus body and located (vertically) between the floor line and the beltline.
- E. Signs, if used, placed on the rear of the bus relating to school bus flashing signal lamps or railroad stop procedures may be of reflective material.

RUB RAILS

- A. There shall be one rub rail located on each side of the bus at seat cushion level which extends from the rear side of the entrance door completely around the bus body (except the emergency door or any maintenance access door) to the point of curvature near the outside cowl on the left side.
- B. There shall be one additional rub rail located on each side at, or no more than 10 inches above, the floor line. The rub rail shall cover the same longitudinal area as the upper rub rail, except at the wheel housings, and it shall extend only to the radii of the right and left rear corners.
- C. Both rub rails shall be attached at each body post and at all other upright structural members.
- D. Each rub rail shall be four inches or more in width in their finished form, shall be constructed of 16-gauge steel or suitable material of equivalent strength and shall be constructed in corrugated or ribbed fashion.
- E. Both rub rails shall be applied outside the body or outside the body posts. (Pressed-in or snap-on rub rails do not satisfy this requirement.) For Type A-1 vehicles using the body provided by the chassis manufacturer or for

Types A-2, B, C and D buses using the rear luggage or the rear engine compartment, rub rails need not extend around the rear corners.

- F. There shall be a rub rail or equivalent bracing located horizontally at the bottom edge of the body side skirts.

SEAT AND RESTRAINING BARRIERS

A. Passenger Seating

1. All seats shall have a minimum cushion depth of 15 inches. All seat backs shall be a minimum of 24 inches high and a minimum of 20 inches from seating reference point. All seats must comply with all requirements of FMVSS No. 222. School bus design capacities shall be in accordance with 49 CFR, Part 571.3 and FMVSS No. 222.
2. All restraining barriers and passenger seats shall be constructed with materials that enable them to meet the criteria contained in the School Bus Seat Upholstery Fire Block Test. (See Appendix B.)
3. Each seat leg shall be secured to the floor by a minimum of two bolts, washers and nuts. Flange-head nuts may be used in lieu of nuts and washers, or seats may be track-mounted in conformance with FMVSS No. 222. If track seating is installed, the manufacturer shall supply minimum and maximum seat spacing dimensions applicable to the bus, which comply with FMVSS No. 222. This information shall be on a label permanently affixed to the bus.
4. All seat frames attached to the seat rail shall be fastened with two bolts, washers and nuts or flange-head nuts.
5. All school buses (including Type A) shall be equipped with restraining barriers which conform to FMVSS No. 222.
6. A flip-up seat may be installed at any side emergency door, provided that it conforms with FMVSS No. 222 and aisle clearance requirements of FMVSS 217. The flip-up seat shall be free of sharp projections on the underside of the seat bottom. The underside of the flip-up seat bottoms shall be padded or contoured to reduce the possibility of clothing being snagged or personal injury during use. Flip-up seats shall be constructed to prevent passenger limbs from becoming entrapped between the seat back and the seat cushion when the seat is in the upright position. The

seat cushion shall be designed to rise to a vertical position automatically when it is not occupied.

B. Pre-School Age Seating

When installed, all passenger seats designed to accommodate a child or infant carrier seat shall comply with FMVSS No. 225. It is recommended these seats be in compliance with NHTSA's "Guideline for the Safe Transportation of Pre-school Age Children in School Buses." (The guidelines are included in Appendix C for informational reference.)

C. Driver Seat

1. The driver's seat supplied by the body company shall be a high back seat with a minimum seat back adjustable to 15 degrees, without requiring the use of tools, and a head restraint to accommodate a 95th percentile adult male, as defined in FMVSS No. 208. The driver's seat shall be secured with nuts, bolts and washers or flanged-head nuts.
2. Type A buses may utilize the standard driver's seat provided by the chassis manufacturer.

D. Driver Restraint System

A Type 2 lap/shoulder belt shall be provided for the driver. The assembly shall be equipped with an automatic locking retractor for the continuous belt system. On all buses except Type A equipped with a standard chassis manufacturer's driver's seat, the lap portion of the belt system shall be guided or anchored to prevent the driver from sliding sideways under it. The lap/shoulder belt shall be designed to allow for easy adjustment in order to fit properly and to effectively protect drivers varying in size from 5th percentile adult female to 95th percentile adult male.

STEERING WHEEL

(See Chassis section.)

STEPS

- A. The first step at service door shall be not less than ten inches and not more than 14 inches from the ground when measured from the top surface of the step to the ground, based on standard chassis specifications, except that on Type D vehicles, the first step at the service door shall be 12 inches to 16 inches from the ground.

- B. Step risers shall not exceed a height of ten inches. When plywood is used on a steel floor or step, the riser height may be increased by the thickness of the plywood.
- C. Steps shall be enclosed to prevent accumulation of ice and snow.
- D. Steps shall not protrude beyond the side bodyline.

STEP TREADS

- A. All steps, including the floor line platform area, shall be covered with 3/16 inch rubber floor covering or other materials equal in wear and abrasion resistance to top grade rubber.
- B. The metal back of the tread shall be permanently bonded to the step tread material.
- C. Steps, including the floor line platform area, shall have a one 1/2-inch nosing that contrasts in color by at least 70 percent measured in accordance with the contrasting color specification in 36 CFR, Part 1192 ADA, Accessibility Guidelines for Transportation Vehicles.
- D. Step treads shall have the following characteristics:
 - 1. Special compounding for good abrasion resistance and coefficient of friction of at least 0.6 for the step surface, and 0.8 for the step nosing;
 - 2. Flexibility so that it can be bent around a 1/2 inch mandrel both at 130 degrees Fahrenheit and 20 degrees Fahrenheit without breaking, cracking or crazing; and
 - 3. A durometer hardness of 85 to 95.

STIRRUP STEPS

If the windshield and lamps are not easily accessible from the ground, there may be at least one folding stirrup step or recessed foothold and suitably located handles on each side of the front of the body for easy accessibility for cleaning. Steps are permitted in or on the front bumper in lieu of the stirrup steps if the windshield and lamps are easily accessible for cleaning from that position.

STOP SIGNAL ARM

The stop signal arm(s) shall comply with the requirements of FMVSS No. 131.

STORAGE COMPARTMENT (Optional)

A storage container for tools, tire chains, and/or tow chains may be located either inside or outside the passenger compartment. If inside, it shall have a cover capable of being securely latched and fastened to the floor, convenient to either the service door or the emergency door. (The seat cushion may not serve this purpose.)

SUN SHIELD

- A. An interior adjustable transparent sun shield, with a finished edge and not less than 6 inches X 30 inches for Types B, C and D vehicles, shall be installed in a position convenient for use by the driver.
- B. On all Type A buses, the sun shield (visor) shall be installed according to the manufacturer's standard.

TAILPIPE

- A. The tailpipe may be flush with, but shall not extend out more than two inches beyond, the perimeter of the body for side-exit pipe or the bumper for rear-exit pipe.
- B. The tailpipe shall exit to the left of the emergency exit door in the rear of the vehicle or to the left side of the bus in front or behind the rear drive axle. The tailpipe exit location on all Types A-1 or B-1 buses may be according to the manufacturer's standard. The tailpipe shall not exit beneath any fuel filler location or beneath any emergency door.

TOWING ATTACHMENT POINTS

Optional tow eyes, hooks or other devices may be furnished on the rear and attached so they do not project beyond the rear bumper. Tow eyes or hooks for attachment to the rear of the chassis frame shall be furnished by either the chassis or body manufacturer. The installation shall be in accordance with the chassis manufacturer's specifications.

TRACTION ASSISTING DEVICES (Optional)

- A. Where required or used, sanders shall:
 - 1. Be of hopper cartridge-valve type;
 - 2. Have a metal hopper with all interior surfaces treated to prevent condensation of moisture;

3. Be of at least 100 pound (grit) capacity;
4. Have a cover on the filler opening of hopper, which screws into place, thereby sealing the unit airtight;
5. Have discharge tubes extending to the front of each rear wheel under the fender;
6. Have non-clogging discharge tubes with slush-proof, non-freezing rubber nozzles;
7. Be operated by an electric switch with a telltale pilot light mounted on the instrument panel;
8. Be exclusively driver-controlled; and
9. Have a gauge to indicate that the hopper needs refilling when it reaches one-quarter full.

B. Automatic traction chains may be installed.

TRASH CONTAINER AND HOLDING DEVICE (Optional)

Where requested or used, the trash container shall be of UL classified fire resistant polyethylene or equivalent material and be secured by a holding device that is designed to prevent movement and to allow easy removal and replacement; and it shall be installed in an accessible location in the driver's compartment, not obstructing passenger use of the service door.

UNDERCOATING

- A. Entire underside of bus body, including floor sections, cross member and below-floor-line side panels, shall be coated with rust-proofing material for which the material manufacturer has issued a notarized certification of compliance to the bus body builder that materials meet or exceed all performance and qualitative requirements of paragraph 3.4 of Federal Specification TT-C-520b, using modified test procedures* for the following requirements:
 1. Salt spray resistance--pass test modified to 5 percent salt and 1000 hours;
 2. Abrasion resistance--pass; and
 3. Fire resistance--pass

* Test panels are to be prepared in accordance with paragraph 4.6.12 of TT-C-520b with modified procedure requiring that the test be made on a 48-hour air-cured film at a thickness recommended by the material manufacturer.

- B. The undercoating material shall be applied with suitable airless or conventional spray equipment to the recommended film thickness and shall show no evidence of voids in the cured film.

VENTILATION

- A. Auxiliary fans shall meet the following requirements:
 - 1. Fans for left and right sides shall be placed in a location where they can be adjusted for maximum effectiveness and where they do not obstruct vision to any mirror. Note: Type A buses may be equipped with one fan.
 - 2. Fans shall be of six-inch nominal diameter.
 - 3. Fan blades shall be covered with a protective cage. Each fan shall be controlled by a separate switch.
- B. The bus body shall be equipped with a suitably controlled ventilating system of sufficient capacity to maintain proper quantity of air under operating conditions without having to open windows except in extremely warm weather.
- C. Static-type, non-closeable exhaust ventilation shall be installed in a low-pressure area of the roof.
- D. Roof hatches designed to provide ventilation in all types of exterior weather conditions may be provided.

WHEELHOUSING

- A. The wheelhousing opening shall allow for easy tire removal and service.
- B. Wheel housings shall be attached to the floor sheets in such a manner so as to prevent any dust, water or fumes from entering the body. Wheel housings shall be constructed of at least 16-gauge steel.
- C. The inside height of the wheel housings above the floor line shall not exceed 12 inches.

- D. The wheel housings shall provide clearance for installation and use of tire chains on single and dual (if so equipped) power-driving wheels.
- E. No part of a raised wheelhousing shall extend into the emergency door opening.

WINDOWS

- A. Each side window, other than emergency exits designated to comply with FMVSS No. 217, shall provide an unobstructed opening of at least nine inches high but not more than 13 inches high and at least 22 inches wide, obtained by the lowering the window. One side window on each side of the bus may be less than 22 inches wide.
- B. Optional tinted and/or frost-free glazing may be installed in all doors, windows and windshields consistent with federal, state and local regulations.

WINDSHIELD WASHERS

A windshield washer system shall be provided.

WINDSHIELD WIPERS

- A. A two-speed or variable speed windshield wiping system, with an intermittent feature, shall be provided.
- B. The wipers shall be operated by one or more air or electric motors of sufficient power to operate the wipers. If one motor is used, the wipers shall work in tandem to give full sweep of windshield.

WIRING

- A. All wiring shall conform to current SAE standards.
- B. Circuits:
 - 1. Wiring shall be arranged in circuits, as required, with each circuit protected by a fuse or circuit breaker. A system of color and number coding shall be used and an appropriate identifying diagram shall be provided to the end user, along with the wiring diagram provided by the chassis manufacturer. The wiring diagrams shall be specific to the bus model supplied and shall include any changes to wiring made by the body manufacturer. Chassis wiring diagrams shall be supplied to the end user. A system of color- and number-coding shall be used on buses. The

following body interconnecting circuits shall be color-coded as noted:

<u>FUNCTION</u>	<u>COLOR</u>
Left Rear Directional Lamp	Yellow
Right Rear Directional Lamp	Dark Green
Stop Lamps	Red
Back-up Lamps	Blue
Tail Lamps	Brown
Ground	White
Ignition Feed, Primary Feed	Black

The color of the cables shall correspond to SAE J 1128.

2. Wiring shall be arranged in at least six regular circuits as follows:
 - a. Head, tail, stop (brake) and instrument panel lamps;
 - b. Clearance lamps and stepwell lamps that shall be actuated when the service door is open;
 - c. Dome lamps;
 - d. Ignition and emergency door signal;
 - e. Turn signal lamps; and
 - f. Alternately flashing signal lamps.
 3. Any of the above combination circuits may be subdivided into additional independent circuits.
 4. Heaters and defrosters shall be wired on an independent circuit.
 5. Whenever possible, all other electrical functions (such as sanders and electric-type windshield wipers) shall be provided with independent and properly protected circuits.
 6. Each body circuit shall be coded by number or letter on a diagram of circuits and shall be attached to the body in a readily accessible location.
- C. The entire electrical system of the body shall be designed for the same voltage as the chassis on which the body is mounted.

- D. All wiring shall have an amperage capacity exceeding the design load by at least 25 percent. All wiring splices are to be done at an accessible location and noted as splices on the wiring diagram.
- E. A body wiring diagram of a size that can easily be read shall be furnished with each bus body or affixed in an area convenient to the electrical accessory control panel.
- F. The body power wire shall be attached to a special terminal on the chassis.
- G. All wires passing through metal openings shall be protected by a grommet.
- H. Wires not enclosed within the body shall be fastened securely at intervals of not more than 18 inches. All joints shall be soldered or joined by equally effective connectors, which shall be water-resistant and corrosion-resistant.

SPECIFICATIONS FOR SPECIALLY EQUIPPED SCHOOL BUSES

INTRODUCTION

Equipping buses to accommodate students with disabilities is dependent upon the needs of the passengers. While one bus may be fitted with a lift, another may have lap belts installed to secure child seats. Buses so equipped are not to be considered a separate class of school bus, but simply a regular school bus that is equipped for special accommodations.

The specifications in this section are intended to be supplementary to specifications in the chassis and body sections. In general, specially equipped buses shall meet all the requirements of the preceding sections plus those listed in this section. It is recognized by the entire industry that the field of special transportation is characterized by varied needs for individual cases and by a rapidly emerging technology for meeting those needs. A flexible, “common sense” approach to the adoption and enforcement of specifications for these vehicles, therefore, is prudent.

As defined by the Code of Federal Regulations (CFR) 49§571.3, “*Bus* means a motor vehicle with motive power, except a trailer, designed for carrying more than ten persons” (eleven or more including the driver). This definition also embraces the more specific category, *school bus*. Vehicles with 10 or fewer passenger positions (including the driver) cannot be classified as buses. For this reason, the federal vehicle classification *multipurpose passenger vehicle* (CFR 49 § 571.3), or MPV, must be used by manufacturers for these vehicles in lieu of the classification *school bus*. This classification system does not preclude state or local agencies or these national specifications from requiring compliance of school bus-type MPVs with the more stringent federal standards for school buses. The following specifications address modifications as they pertain to school buses that, with standard seating arrangements prior to modification, would accommodate eleven or more including the driver. If by addition of a power lift, mobile seating device positions or other modifications, the capacity is reduced such that vehicles become MPVs, the intent of these specifications is to require these vehicles to meet the same specifications they would have had to meet prior to such modifications, and such MPVs are included in all references to school buses and requirements for school buses which follow.

DEFINITION

A specially equipped school bus is any school bus that is designed, equipped or modified to accommodate students with special needs.

GENERAL REQUIREMENTS

- A. School buses designed for transporting students with special transportation needs shall comply with 5 CSR 30-261.025 Minimum Requirements for

School Bus Chassis and Body incorporated by reference material entitled Missouri Minimum Standards for School Buses and with Federal Motor Vehicle Safety Standards (FMVSS) applicable to their Gross Vehicle Weight Rating (GVWR) category.

- B. Any school bus to be used for the transportation of children who are confined to a wheelchair or other mobile positioning device, or who require life-support equipment that prohibits use of the regular service entrance, shall be equipped with a power lift, unless a ramp is needed for unusual circumstances related to passenger needs.

AISLES

All school buses equipped with a power lift shall provide a minimum 30-inch aisle leading from each wheelchair/mobility aid position to at least one emergency door and the lift area without requiring the movement of any other wheelchair or mobility aid. A wheel chair securement position shall never be located closer than 30-inches directly in front of a power lift door location.

COMMUNICATIONS

All school buses that are used to transport individuals with disabilities should be equipped with a two-way electronic voice communication system that can be used at any point in the vehicle's route. Where no such service exists, vehicles would be exempt.

GLAZING

Tinted glazing may be installed in all doors, windows and windshields consistent with federal, state and local regulations.

IDENTIFICATION

Buses with power lifts used for transporting individuals with disabilities shall display the International Symbol of Accessibility below the window line. Such emblems shall be white on blue or black background, shall not exceed 12 inches in size, and shall be of a high-intensity reflectorized material meeting Federal Highway Administration (FHWA) FP-85 Standards.

PASSENGER CAPACITY RATING

In determining the passenger capacity of a school bus for purposes other than actual passenger load (e.g., vehicle classification or various billing/reimbursement models), any location in a school bus intended for securement of an occupied wheelchair/mobility aid during vehicle operations is regarded as four designated

seating positions. Similarly, each lift area may be regarded as four designated seating positions.

POWER LIFTS AND RAMPS

A. The power lift shall be located on the right side of the bus body when not extended. Exception: The lift may be located on the left side of the bus if, and only if, the bus is primarily used to deliver students to the left side of one-way streets.

1. A ramp device may be used in lieu of a mechanical lift if the ramp meets all the requirements of the Americans with Disabilities Act (ADA) as found in 36 CFR §1192.23 Vehicle ramp. (See Appendix D.)
2. A ramp device that does not meet the specifications of ADA but does meet the specifications of paragraph c of this section may be installed and used, when, and only when, a power lift system is not adequate to load and unload students having special and unique needs. A readily accessible ramp may be installed for emergency exit use. If stowed in the passenger compartment, the ramp must be properly secured and placed away from general passenger contact. It must not obstruct or restrict any aisle or exit while in its stowed or deployed position.
3. All vehicles covered by this specification shall provide a level-change mechanism or boarding device (e.g., lift or ramp) complying with paragraph 2 or 3 of this section with sufficient clearances to permit a wheelchair or other mobility aid user to reach a securement location.

B. Vehicle lift

1. Design loads. The design load of the lift shall be at least 600 pounds. Working parts, such as cables, pulleys and shafts, which can be expected to wear, and upon which the lift depends for support of the load, shall have a safety factor of at least six, based on the ultimate strength of the material. Non-working parts, such as platform, frame and attachment hardware that would Not be expected to wear, shall have a safety factor of at least three, based on the ultimate strength of the material.

Lift capacity. The lifting mechanism and platform shall be capable of lifting at least 800 pounds.

2. Controls

(a) Requirements

Controls shall be provided that enable the operator to activate the lift mechanism from either inside or outside the bus. The controls may be interlocked with the vehicle brakes, transmission or door, or they may provide other appropriate mechanisms or systems to ensure the vehicle cannot be moved when the lift is not stowed and so the lift cannot be deployed unless the interlocks or systems are engaged. The lift shall deploy to all levels (e.g., ground, curb and intermediate positions) normally encountered in the operating environment. Where provided, each control for deploying, lowering, raising and stowing the lift and lowering the roll-off barrier shall be of a momentary contact type requiring continuous manual pressure by the operator and shall not allow improper lift sequencing when the lift platform is occupied. The controls shall allow reversal of the lift operation sequence, such as raising or lowering a platform that is part way down, without allowing an occupied platform to fold or retract into the stowed position.

(b) Exception

Where the lift is designed to deploy with its long dimension parallel to the vehicle axis which pivots into or out of the vehicle while occupied (i.e., “rotary lift”), the requirements of this paragraph, prohibiting the lift from being stowed while occupied, shall not apply if the stowed position is within the passenger compartment and the lift is intended to be stowed while occupied.

3. Emergency operation

The lift shall incorporate an emergency method of deploying, lowering to ground level with a lift occupant, and raising and stowing the empty lift if the power to the lift fails. No emergency method, manual or otherwise, shall be capable of being operated in a manner that could be hazardous to the lift occupant or to the operator when operated according to the manufacturer’s instructions and shall not permit the platform to be stowed or folded when occupied, unless the lift is a rotary lift and is intended to be stowed while occupied. No manual emergency operation

shall require more than two minutes to lower an occupied wheelchair to ground level.

4. Power or equipment failure

Platforms stowed in a vertical position, and deployed platforms when occupied, shall have provisions to prevent their deploying, falling or folding any faster than 12 inches per second or their dropping of an occupant in the event of a single failure of any load-carrying component.

5. Platform barriers

The lift platform shall be equipped with barriers to prevent any of the wheels of a wheelchair or mobility aid from rolling off the platform during its operation. A movable barrier or inherent design feature shall prevent a wheelchair or mobility aid from rolling off the edge closest to the vehicle until the platform is in its fully raised position. Each side of the lift platform that extends beyond the vehicle in its raised position shall have a barrier with a minimum height of one and one-half inches. Such barriers shall not interfere with maneuvering into or out of the aisle. The loading-edge barrier (outer barrier), which functions as a loading ramp when the lift is at ground level, shall be sufficient when raised or closed, or a supplementary system shall be provided, to prevent a power wheelchair or mobility aid from riding over or defeating it. The outer barrier of the lift shall automatically raise or close, or a supplementary system shall automatically engage, and remain raised, closed or engaged at all times that the platform is more than three inches above the roadway or sidewalk and the platform is occupied. Alternatively, a barrier or system may be raised, lowered, opened, closed, engaged or disengaged by the lift operator, provided an inter-lock or inherent design feature prevents the lift from rising unless the barrier is raised or closed or the supplementary system is engaged.

6. Platform surface

The platform surface shall be free of any protrusions over 1/4 inch high and shall be slip resistant. The platform shall have a minimum clear width of 28 1/2 inches at the platform, a minimum clear width of 30 inches measured from two inches above the platform surface to 30 inches above the surface of the platform, and a minimum clear length of 48 inches measured from two inches above the surface of the platform to 30 inches above the

surface of the platform. (See “Wheelchair or Mobility Aid Envelope” figure in Appendix D.)

7. Platform gaps

Any openings between the platform surface and the raised barrier shall not exceed 5/8 inches in width. When the platform is at vehicle floor height with the inner barrier (if applicable) down or retracted, gaps between the forward lift platform edge and the vehicle floor shall not exceed 1/2 inch horizontally and 5/8 inch vertically. Platforms on semi-automatic lifts may have a handhold not exceeding 1 1/2 inches by 4 1/2 inches located between the edge barriers.

8. Platform entrance ramp

The outboard entrance ramp or loading-edge barrier used as a ramp and the transition plate from the inboard edge of the platform to the vehicle floor shall not exceed a slope of 1:8, measured on level ground, for a maximum rise of three inches, and the transition from roadway or sidewalk to ramp may be vertical without edge treatment up to 1/4 inch. Thresholds between 1/4 inch and 1/2 inch high shall be beveled with a slope no greater than 1:2.

9. Platform deflection

The lift platform (not including the entrance ramp) shall not deflect more than three degrees (exclusive of vehicle roll or pitch) in any direction between its unloaded position and its position when loaded with 600 pounds applied through a 26 inches by 26 inches test pallet at the centroid of the platform.

10. Platform movement

No part of the platform shall move at a rate exceeding six inches per second while lowering and lifting an occupant, and shall not exceed 12 inches per second during deploying or stowing. This requirement does not apply to the deployment or stowage cycles of lifts that are manually deployed or stowed. The maximum platform horizontal and vertical acceleration when occupied shall be 0.3 g.

11. Boarding direction

The lift shall permit both inboard and outboard facing of wheelchair and mobility aid users.

12. Use by standees

Lifts shall accommodate persons who are using walkers, crutches, canes or braces, or who otherwise have difficulty using steps. The platform may be marked to indicate a preferred standing position.

13. Handrails

Platforms on lifts shall be equipped with handrails on two sides, which move in tandem with the lift, and which shall be graspable and provide support to standees throughout the entire lift operation. Handrails shall have a usable component at least eight inches long with the lowest portion a minimum of 30 inches above the platform and the highest portion a maximum of 38 inches above the platform. The handrails shall be capable of withstanding a force of 100 pounds concentrated at any point on the handrail without permanent deformation of the rail or its supporting structure. The handrail shall have a cross-sectional diameter between 1 1/4 inches and 1 1/2 inches or shall provide an equivalent grasping surface, and have eased edges with corner radii of not less than 1/8 inches. Handrails shall be placed to provide a minimum 1 1/2 inches knuckle clearance from the nearest adjacent surface. Handrails shall not interfere with wheelchair or mobility aid maneuverability when entering or leaving the vehicle.

14. Circuit breaker

A resettable circuit breaker shall be installed between the power source and the lift motor if electrical power is used. It shall be located as close to the power source as possible, but not within the passenger/driver compartment.

15. Excessive pressure

Lift design shall prevent excessive pressure that could damage the lift system when the platform is fully lowered or raised or that could jack the vehicle.

16. Documentation

The following information shall be provided with each vehicle equipped with a lift:

- (1) A phone number where information can be obtained about installation, repair and parts. (Detailed written instructions and a parts list shall be available upon request.)

- (2) Detailed instructions regarding use of the lift and readily visible when the lift door is open, including a diagram showing the proper placement and positioning of wheelchair/mobility aids on lift.

17. Training materials

The lift manufacturer shall make available training materials to ensure the proper use and maintenance of the lift. These may include instructional videos, classroom curriculum, system test results or other related materials.

18. Identification and certification

Each lift shall be permanently and legibly marked or shall incorporate a non-removable label or tag that states that it conforms to all applicable requirements of the current National School Transportation Specifications and Procedures. In addition, the lift manufacturer or an authorized representative, upon request of the original titled purchaser, shall provide a notarized Certificate of Conformance, either original or photocopied, which states that the lift system meets all the applicable requirements of the current National School Transportation Specifications and Procedures.

C. Vehicle ramp

1. If a ramp is used, it shall be of sufficient strength and rigidity to support the special device, occupant and attendant(s). It shall be equipped with a protective flange on each longitudinal side to keep the special device on the ramp.
2. Floor of the ramp shall be constructed of non-skid material.
3. Ramp shall be equipped with handles and shall be of weight and design to permit one person to put the ramp in place and return it to its storage place.
4. Ramps used for emergency evacuation purposes may be installed in raised floor buses by manufacturers. They shall not be installed as a substitute for a lift when a lift is capable of servicing the need.

REGULAR SERVICE ENTRANCE

- A. On power lift-equipped vehicles, steps shall be the full width of the step well, excluding the thickness of the doors in the open position.

- B. A suitable device shall be provided to assist passengers during ingress or egress. This device shall allow for easy grasping or holding and shall have no openings or pinch points that might entangle clothing, accessories or limbs.

RESTRAINING DEVICES

- A. On power lift-equipped vehicles, seat frames may be equipped with attachments or devices to which belts, restraining harnesses or other devices may be attached. Attachment framework or anchorage devices, if installed, shall conform to FMVSS No. 210.
- B. Belt assemblies, if installed, shall conform to FMVSS No. 209.
- C. Child restraint systems, which are used to facilitate the transportation of children who in other modes of transportation would be required to use a child, infant or booster seat, shall conform to FMVSS No. 213.

SEATING ARRANGEMENTS

Flexibility in seat spacing to accommodate special devices shall be permitted to meet passenger requirements. All seating shall be forward-facing.

SECUREMENT AND RESTRAINT SYSTEM FOR WHEELCHAIR/MOBILITY AID AND OCCUPANT

For purposes of better understanding the various aspects and components of this section, the term *securement* or phrase *securement system* is used exclusively in reference to the device(s) which secures the wheelchair/mobility aid. The term *restraint* or phrase *restraint system* is used exclusively in reference to the device(s) used to restrain the occupant of the wheelchair/mobility aid. The phrase *securement and restraint system* is used to refer to the total system that secures and restrains both the wheelchair/mobility aid and the occupant.

- A. Securement and restraint system—general
 - 1. The Wheelchair/Mobility Aid Securement and Occupant Restraint System shall be designed, installed and operated to accommodate passengers in a forward-facing orientation within the bus and shall comply with all applicable requirements of FMVSS No. 222. Gurney-type devices shall be secured parallel to the side of the bus.
 - 2. The securement and restraint system, including the system track, floor plates, pockets or other anchorages shall be provided by the same manufacturer or shall be certified to be compatible by manufacturers of all equipment/systems used.

3. When a wheelchair/mobility aid securement device and an occupant restraint share a common anchorage, including occupant restraint designs that attach the occupant restraint to the securement device or the wheelchair/mobility aid, the anchorage shall be capable of withstanding the loads of both the securement device and the occupant restraint applied simultaneously, in accordance with FMVSS No. 222. (See §B and §C of this section.)
4. When a wheelchair/mobility aid securement device (webbing or strap assembly) is shared with an occupant restraint, the wheelchair/mobility aid securement device (webbing or strap assembly) shall be capable of withstanding a force twice the amount specified in §4.4(a) of FMVSS No. 209. (See §B and §C of this section.)
5. The bus body floor and sidewall structures where the securement and restraint system anchorages are attached shall have equal or greater strength than the load requirements of the system(s) being installed.
6. The occupant restraint system shall be designed to be attached to the bus body either directly or in combination with the wheelchair/mobility aid securement system, by a method which prohibits the transfer of weight or force from the wheelchair/mobility aid to the occupant in the event of an impact.
7. When an occupied wheelchair/mobility aid is secured in accordance with the manufacturer's instructions, the securement and restraint system shall limit the movement of the occupied wheelchair/mobility aid to no more than two inches in any direction under normal driving conditions.
8. The securement and restraint system shall incorporate an identification scheme that will allow for the easy identification of the various components and their functions. It shall consist of one of the following, or a combination thereof:
 - a. The wheelchair/mobility aid securement (webbing or strap assemblies) and the occupant restraint belt assemblies shall be of contrasting color or color shade.
 - b. The wheelchair/mobility aid securement device (webbing or strap assemblies) and occupant restraint belt assemblies shall be clearly marked to indicate the proper wheelchair orientation in the vehicle, and the name and location for

each device or belt assembly, i.e., front, rear, lap belt, shoulder belt, etc.

9. All attachment or coupling devices designed to be connected or disconnected frequently shall be accessible and operable without the use of tools or other mechanical assistance.
10. All securement and restraint system hardware and components shall be free of sharp or jagged areas and shall be of a non-corrosive material or treated to resist corrosion in accordance with §4.3(a) of FMVSS No. 209.
11. The securement and restraint system shall be located and installed such that when an occupied wheelchair/mobility aid is secured, it does not block access to the lift door.
12. A device for storage of the securement and restraint system shall be provided. When the system is not in use, the storage device shall allow for clean storage of the system, shall keep the system securely contained within the passenger compartment, shall provide reasonable protection from vandalism and shall enable the system to be readily accessed for use.
13. The entire securement and restraint system, including the storage device, shall meet the flammability standards established in FMVSS No. 302.
14. Each securement device (webbing or strap assembly) and restraint belt assembly shall be permanently and legibly marked or shall incorporate a non-removable label or tag that states that it conforms to all applicable FMVSS requirements, as well as the current National School Transportation Specifications and Procedures. In addition, the system manufacturer, or an authorized representative, upon request by the original titled purchaser, shall provide a notarized Certificate of Conformance, either original or photocopied, which states that the wheelchair/mobility aid securement and occupants' restraint system meets all requirements as specified in FMVSS No. 222 and the current National School Transportation Specifications and Procedures.
15. The following information shall be provided with each vehicle equipped with a securement and restraint system:

- a. A phone number where information can be obtained about installation, repair, and parts. (Detailed written instructions and a parts list shall be available upon request.)
 - b. Detailed instructions regarding use, including a diagram showing the proper placement of the wheelchair/mobility aids and positioning of securement devices and occupant restraints, including correct belt angles.
16. The system manufacturer shall make available training materials to ensure the proper use and maintenance of the wheelchair/mobility aid securement and occupant restraint system. These may include instructional videos, classroom curriculum, system test results or other related materials.

B. Wheelchair/mobility aid securement system

1. Each location for the securement of a wheelchair/mobility aid shall have a minimum of four anchorage points. A minimum of two anchorage points shall be located in front of the wheelchair/mobility aid and a minimum of two anchorage points shall be located in the rear. The securement anchorages shall be attached to the floor of the vehicle and shall not interfere with passenger movement or present any hazardous condition.
2. Each securement system location shall have a minimum clear floor area of 30 inches wide by 48 inches long. Additional floor area may be required for some applications. Consultation between the user and the manufacturer is recommended to ensure the adequate area is provided.
3. The securement system shall secure common wheelchair/mobility aids and shall be able to be attached easily by a person who has average dexterity and who is familiar with the system and wheelchair/mobility aid.
4. As installed, each securement anchorage shall be capable of withstanding a minimum force of 3,000 pounds when applied as specified in FMVSS No. 222. When more than one securement device shares a common anchorage, the anchorage shall be capable of withstanding the force indicated above, multiplied by the number of securement devices sharing that anchorage.
5. Each securement device, if incorporating webbing or a strap assembly, shall comply with the requirements for Type 1 lap belt

systems, in accordance with §4.2, §4.3, and §4.4(a) of FMVSS No. 209.

6. The securement system shall secure the wheelchair/mobility aid in such a manner that the attachments or coupling hardware will not become detached when any wheelchair/mobility aid component deforms, when one or more tires deflate, and without intentional operation of a release mechanism (e.g., a spring clip on a securement hook).
7. Each securement device (webbing or strap assembly) shall be capable of withstanding a minimum force of 2,500 pounds when tested in accordance with FMVSS No. 209.
8. Each securement device (webbing or strap assembly) shall provide a means of adjustment, per the manufacturer's design, to remove slack from the device or assembly.

C. Occupant restraint system

1. A Type 2 lap/shoulder belt restraint system that meets all applicable requirements of FMVSS Nos. 209 and 210 shall provide for restraint of the occupant.
2. The occupant restraint system shall be made of materials that do not stain, soil or tear an occupant's clothing, and shall be resistant to water damage and fraying.
3. Each restraint system location shall have not less than one anchorage of manufacturer's design for the upper end of the upper torso restraint.

The anchorage for each occupant's upper torso restraint shall be capable of withstanding a minimum force of 1,500 pounds when applied as specified in FMVSS No. 222.

4. Each wheelchair/mobility aid location shall have not less than two floor anchorages for the occupant pelvic restraint and the connected upper torso restraint.
 - a. Each floor anchorage shall be capable of withstanding a minimum force of 3,000 pounds when applied as specified in FMVSS No. 222.
 - b. When more than one occupant restraint shares a common anchorage, the anchorage shall be capable of withstanding

a minimum force of 3,000 pounds multiplied by the number of occupant restraints sharing the common anchorage in accordance with FMVSS No. 222.

5. Each floor and wall anchorage that secures the occupant restraint to the vehicle which is not permanently attached, shall be of a “positive latch” design and shall not allow for any accidental disconnection.

D. Dynamic testing

1. The wheelchair/mobility aid securement and occupant restraint system shall be subjected to and successfully pass a dynamic sled test at a minimum impact speed/deceleration of 30 mph/20g's.
2. The dynamic test shall be performed by experienced personnel using an impact simulator with proven ability to provide reliable, accurate test results that can be replicated.
3. The dynamic test shall be performed in accordance with the procedures set forth in Appendix A of SAE J2249: “Test for Frontal Impact Crash Worthiness.”
4. The wheelchair/mobility aid used for testing purposes shall be a rigid, reusable surrogate wheelchair that complies with the requirements of Appendix D of SAE J2249: “Specification for Surrogate Wheelchair.”
5. The dynamic test shall be performed using system assemblies, components and attaching hardware that are identical to the final installation in type, configuration and positioning. The body structure at the anchorage points may be simulated for the purpose of the sled test.
6. When tested, the wheelchair/mobility aid securement and occupant restraint system shall pass the criteria specified in Section 6.2 of SAE J2249: “Performance Requirements of Frontal Sled Impact Test.” Following is an abridged summary of the criteria presented in Appendix D.
 - a. Retain the test dummy in the test wheelchair and on the test sled with the test wheelchair in an upright position.
 - b. Do not show any fragmentation or complete separation of any load carrying part.

- c. Do not allow the horizontal excursions of the test dummy and the test wheelchair to exceed specified limits.
- d. Prevent the test wheelchair from imposing forward loads on the test dummy.
- e. Allow removal of the test dummy and the test wheelchair subsequent to the test, without the use of tools.

SPECIAL LIGHT

Doorways in which lifts are installed shall have for use during lift operation a special light providing a minimum of two foot-candles of illumination measured on the floor of the bus immediately adjacent to the lift and on the lift when deployed at the vehicle floor level.

SPECIAL SERVICE ENTRANCE

- A. Power lift-equipped bodies shall have a special service entrance to accommodate the power lift.

Exception: If the lift is designed to operate within the regular service entrance, and is capable of stowing such that the regular service entrance is not blocked in any way, and that persons entering or exiting the bus are not impeded in any way, a special service entrance shall not be required.

- B. The special service entrance and door shall be located on the right side of the bus and shall be designed so as not to obstruct the regular service entrance.

Exception: A special service entrance and door may be located on the left side of the bus only if the bus is used primarily to deliver students to the left side of one-way streets and its use is limited to that function.

- C. The opening may extend below the floor through the bottom of the body skirt. If such an opening is used, reinforcements shall be installed at the front and rear of the floor opening to support the floor and give the same strength as other floor openings.
- D. A drip molding shall be installed above the opening to effectively divert water from the entrance.
- E. Door posts and headers at the entrance shall be reinforced sufficiently to provide support and strength equivalent to the areas of the side of the bus not used for the special service entrance.

SPECIAL SERVICE ENTRANCE DOORS

- A. A single door or double doors may be used for the special service entrance.
- B. A single door shall be hinged to the forward side of the entrance unless doing so would obstruct the regular service entrance. If the door is hinged to the rearward side of the doorway, the door shall utilize a safety mechanism which will prevent the door from swinging open should the primary door latch fail. If double doors are used, the system shall be designed to prevent the door(s) from being blown open by the wind resistance created by the forward motion of the bus, and/or shall incorporate a safety mechanism to provide secondary protection should the primary latching mechanism(s) fail.
- C. All doors shall have positive fastening devices to hold doors in the “open” position.
- D. All doors shall be weather sealed.
- E. When manually operated dual doors are provided, the rear door shall have at least a one-point fastening device to the header. The forward-mounted door shall have at least three one-point fastening devices. One shall be to the header, one to the floor line of the body, and the other shall be into the rear door. The door and hinge mechanism shall be of a strength that is greater than or equivalent to the emergency exit door.
- F. Door materials, panels and structural strength shall be equivalent to the conventional service and emergency doors. Color, rub rail extensions, lettering and other exterior features shall match adjacent sections of the body.
- G. Each door shall have windows set in rubber that are visually similar in size and location to adjacent non-door windows. Glazing shall be of the same type and tinting (if applicable) as standard fixed glass in other body locations.
- H. Door(s) shall be equipped with a device that will actuate an audible or flashing signal located in the driver’s compartment when the door(s) is not securely closed and the ignition is in the “on” position.
- I. A switch shall be installed so that the lifting mechanism will not operate when the lift platform door(s) is closed.

- J. Special service entrance doors shall be equipped with padding at the top edge of the door opening. Padding shall be at least three inches wide and one inch thick and shall extend the full width of the door opening.

SUPPORT EQUIPMENT AND ACCESSORIES

- A. Each bus that is set up to accommodate wheelchair/mobility aids or other assistive or restraint devices that utilize belts shall contain at least one belt cutter properly secured in a location within reach of the driver while belted into his/her driver's seat. The belt cutter shall be durable and designed to eliminate the possibility of the operator or others being cut during use.
- B. Special equipment or supplies that are used on the bus for mobility assistance, health support or safety purposes shall meet any local, federal or engineering standards that may apply, including proper identification.

Equipment that may be used for these purposes includes, but is not limited to:

- 1. Wheelchairs and other mobile seating devices. (See section on Securement and Restraint System for Wheelchair/Mobility Aid and Occupant.)
 - 2. Crutches, walkers, canes and other ambulating devices.
 - 3. Medical support equipment. This may include respiratory devices such as oxygen bottles (which should be no larger than 22 cubic feet for liquid oxygen and 38 cubic feet for compressed gas) or ventilators. Tanks and valves should be located and positioned to protect them from direct sunlight, bus heater vents or other heat sources. Other equipment may include intravenous and fluid drainage apparatus.
- C. All portable equipment and special accessory items, including the equipment listed above, shall be secured at the mounting location to withstand a pulling force of five times the weight of the item or shall be retained in an enclosed, latched compartment. The compartment shall be capable of withstanding forces applied to its interior equal to five times the weight of its contents without failure of the box's integrity and securement to the bus. Exception: If these specifications provide specific requirements for securement of a particular type of equipment, the specific specification shall prevail (e.g., wheelchairs).

TECHNOLOGY AND EQUIPMENT, NEW

It is the intent of these specifications to accommodate new technologies and equipment that will better facilitate the transportation of students with special needs. When a new technology, piece of equipment or component is desired to be applied to the school bus and it meets the following criteria, it is acceptable:

- A. The technology, equipment or component shall not compromise the effectiveness or integrity of any major safety system. (Examples of safety systems include, but are not limited to, compartmentalization, the eight-lamp warning system, emergency exits and the yellow color scheme.)
- B. The technology, equipment or component shall not diminish the safety of the interior of the bus.
- C. The technology, equipment or component shall not create additional risk to students who are boarding or exiting the bus or are in or near the school bus loading zone.
- D. The technology, equipment or component shall not require undue additional activity and/or responsibility for the driver.
- E. The technology, equipment or component shall generally increase efficiency and/or safety of the bus, generally provide for a safer or more pleasant experience for the occupants and pedestrians in the vicinity of the bus or shall generally assist the driver and make his/her many tasks easier to perform.

ALTERNATIVE FUELS

INTRODUCTION

This section is designed to be used as an overview of the alternative fuels being utilized for school transportation. It is not designed to replace current applicable federal, state, manufacturing or safety specifications that may exceed requirements within this section. There may be advancements in engineering and improvements in equipment fabrication methods and operating practices that differ from those specifically called for in this section. Such deviations or improvements may provide safety and may meet the intent of, and be compatible with, this section. Entities wishing to purchase alternative fuel school buses should use this section only as a starting point. More detailed specifications, including specific design and performance criteria and safety specifications, should be researched by prospective purchasers of alternative-fuel school buses.

GENERAL REQUIREMENTS

Alternative fuel school buses shall meet the following requirements:

- A. Chassis shall meet all specifications previously mentioned in BUS CHASSIS SPECIFICATIONS.
- B. Chassis shall meet all applicable Federal Motor Vehicle Safety Standards (FMVSS).
- C. The fuel system integrity shall meet the specified leakage performance standards when impacted by a moving contoured barrier in accordance with test conditions specified in FMVSS No. 301 or FMVSS No. 303, as applicable.
- D. Original equipment manufacturers (OEMs) and conversion systems using compressed natural gas (CNG) shall comply with National Fire Protection Association (NFPA) Specification 52 A, "Compressed Natural Gas Vehicular Fuel Systems," in effect at the time of installation. Fuel systems using liquefied petroleum gas (LPG) shall comply with NFPA Specification 58 A "Liquefied Petroleum Gases Engine Fuel Systems" in effect at the time of installation.
- E. All alternative fuel buses shall be capable of traveling not less than 200 miles with a full load, except those powered by electricity shall be capable of traveling not less than 80 miles.
- F. Natural gas-powered buses shall be equipped with an interior/exterior gas detection system. All natural gas-powered buses shall be equipped with an automatic or manual fire detection and suppression system.

- G. All materials and assemblies used to transfer or store alternative fuels shall be installed outside the passenger/driver compartment.
- H. All Types C and D buses using alternative fuels shall meet the same base requirements of BUS CHASSIS SPECIFICATIONS for Power and Gradeability i.e., at least one published net horsepower per each 185 pounds of Gross Vehicle Weight Rating (GVWR.)
- I. The total weight shall not exceed the GVWR when loaded to rated capacity.
- J. The manufacturer supplying the alternative fuel equipment must provide the owner and operator with adequate training and certification in fueling procedures, scheduled maintenance, troubleshooting and repair of alternative fuel equipment.
- K. All fueling equipment shall be designed specifically for fueling motor vehicles and shall be certified by the manufacturer as meeting all applicable federal, state and industry standards.
- L. All on-board fuel supply containers shall meet all appropriate requirements of the American Society for Mechanical Engineering (ASME) code, DOT regulations or applicable FMVSSs and NFPA standards.
- M. All fuel supply containers shall be securely mounted to withstand a static force of eight times their weight in any direction.
- N. All safety devices that discharge to the atmosphere shall be vented to the outside of the vehicle. The discharge line from the safety relief valve on all school buses shall be located in a manner appropriate to the characteristics of the alternative fuel. Discharge lines shall not pass through the passenger compartment.
- O. A positive, quick-acting (1/4 turn) shut-off control valve shall be installed in each gaseous fuel supply line, as close as possible to the fuel supply containers. The valve controls shall be placed in a location easily operable from the exterior of the vehicle. The location of the valve controls shall be clearly marked on the exterior surface of the bus.
- P. An electrical grounding system shall be required for grounding of the fuel system during maintenance-related venting.

CHARACTERISTICS OF ALTERNATIVE FUELS

For the purpose of this section, alternative fuels refer to the specific fuels listed below. A brief description of each fuel and the advantages and disadvantages of each fuel are shown. (The last page in this section is the alternative fuels comparison chart.)

Note: Two other more exotic fuels are being examined: hydrogen and solar power. These two energy sources are in their infancy as alternative fuels for motor vehicles and are not covered within the scope of this section.

A. Liquid alternative fuels

1. Methanol

Methanol, a liquid at normal ambient temperatures, is colorless and is made primarily from natural gas or coal. Extensive experiments have been conducted with automobile and truck engines powered by methanol. There are a number of urban transit bus fleets currently using methanol. California has experience with methanol as an alternative fuel for school buses through its School Bus Demonstration Project. The findings clearly determined methanol fuel to be costly to operate and unreliable.

a. Advantages:

- (1) The principal advantage of methanol is that the emissions produced are quite low in particulates and NO_x.
- (2) Methanol mixes with gasoline and can be used as M85, which is 15 percent gasoline and 85 percent methanol with flexible-fuel vehicles running on a blend of the two fuels.
- (3) Methanol has a high octane rating which assists gasoline (spark ignition) engine performance.
- (4) Methanol is biodegradable and readily assimilates with water.
- (5) Methanol burns smokeless.
- (6) Methanol is a domestically produced energy source.

b. Disadvantages:

- (1) Methanol is corrosive, particularly to aluminum; engines and fuel systems specially designed to handle it use different materials, such as stainless steel.
- (2) Methanol has less than half the power per equivalent gallon (BTU value) as diesel fuel. For an equivalent range, this requires storage tanks twice the size of diesel tanks.
- (3) Methanol is quite toxic. Direct exposure to the human body has the potential of causing blindness and kidney failure. Since it is tasteless and colorless, it cannot easily be detected should it get into a water supply.
- (4) Methanol combustion generates high amounts of formaldehyde, a potential cancer causing substance. This can be offset with exhaust after-treatment, such as special catalytic converters.
- (5) In its pure state, methanol burns with a colorless flame, so a fire is hard to see. It is less volatile than gasoline but has a relatively low flash point of 54 degrees Fahrenheit.
- (6) The distribution system and infrastructure for methanol fueling are considerably less widespread than for gasoline and diesel.
- (7) Methanol has a low cetane rating, which inhibits diesel engine performance. It is not suitable for blending with diesel fuel.
- (8) Methanol has been proven to be unsafe when operating in certain ambient temperature ranges.

2. Ethanol

Ethanol is a distilled agricultural alcohol product that is a liquid and is colorless at normal ambient temperatures. Corn is the current primary grain source. It has many of the same characteristics as methanol. Currently, ethanol is used primarily in a mixture with gasoline, usually no more than 10% ethanol.

a. Advantages:

- (1) Ethanol emissions are quite low in particulates and NO_x.
- (2) Like methanol, ethanol readily mixes with gasoline.
- (3) Ethanol is biodegradable and readily assimilates with water.
- (4) Ethanol is less corrosive and less toxic than methanol.
- (5) Ethanol is a domestically produced energy source.

b. Disadvantages:

- (1) The production process is extensive and the steps involved (i.e., planting, fertilizing, harvesting, shipping and processing) consume nearly as much energy as is created by the fuel.
- (2) The energy output of ethanol, though higher than methanol, is still only about half that of diesel fuel; thus, the range of ethanol-powered vehicles is limited for a given fuel storage capacity.
- (3) Ethanol emissions have some visible smoke.
- (4) Ethanol produces formaldehyde, however, this can be offset with an exhaust after-treatment.
- (5) The distribution system and infrastructure for ethanol fueling are considerably less widespread than for gasoline and diesel.

3. Clean diesel

Clean diesel was one of the alternative fuels approved in the Clean Air Act Amendments of 1990. The first step to be undertaken was further refining to reduce sulfur content and hence the significant particulate emissions caused by the sulfur. Significant advancement in this process has resulted in the development of ultra-low sulfur content diesel fuel. Refinery techniques can now produce diesel fuel with a sulfur content below 15 parts per million

(PPM). The availability of this fuel supports the installation of an advanced exhaust after-treatment device in the form of a continuously regenerating trap (CRT). This CRT technology reduces the exhaust particulate content by approximately 90 percent from currently mandated levels (to point .005 grams/hp-hr) and the hydrocarbons to an unmeasurable level (to essentially zero). Further steps are being developed to add cetane boosters, which increase efficient combustion.

a. Advantages:

- (1) The additional processing costs are small, so clean and ultra-low sulfur diesels are cost-effective relative to other alternative fuels.
- (2) All existing diesel engines currently in service can use clean or ultra-low sulfur diesel without modification.
- (3) The present systems for distribution of diesel fuel are unchanged and are fully usable with clean diesel.
- (4) Clean and ultra-low sulfur diesel retains the low level of diesel fuel volatility. This makes it safer than many other alternatives.
- (5) Clean and ultra-low sulfur diesel has a higher BTU value per gallon or equivalent gallon than any other alternative fuel, and thus provides more engine efficiency, as well as more vehicle range.
- (6) Ultra-low sulfur diesel offers significant reductions in emissions.

b. Disadvantages:

- (1) Clean diesel is still relatively high in particulates and NOx.
- (2) Clean and ultra-low sulfur diesel are fossil fuels and, as such, still leave the country dependent on foreign sources.
- (3) When operating under cold conditions, starting is a problem, as with all diesel fuels.

- (4) Ultra-low sulfur diesel is not readily available in most areas of the country.

4. Reformulated gasoline

Reformulated gasoline is specially blended fuel with the following properties: (1) lower vapor pressure that reduces evaporation during operation and refueling, and (2) more efficient combustion through the addition of high-octane oxygenates. Reformulated gasoline aromatic levels have been lowered, which provides less in the way of hydrocarbon tail pipe emissions.

a. Advantages:

- (1) Reformulated gasoline is compatible with all existing gasoline engines.
- (2) The existing fuel-delivery infrastructure is unchanged by this change in fuel properties.
- (3) Reformulated gasoline is a cost-effective alternative in spite of some additional refining costs.

b. Disadvantages:

- (1) Currently there is insufficient oxygenate production and storage (as well as transportation) to provide the oxygenate when and where it is needed.
- (2) Like regular gasoline, reformulated gasoline has a lower caloric (BTU) value than diesel and, thus, provides less engine efficiency than diesel and less range for a given fuel capacity.
- (3) Reformulated gasoline is a fossil fuel and, as such, still leaves the country dependent on foreign sources.
- (4) Present technology and federal emissions and energy standards will allow reformulated gasoline to be viable to the year 2000. Significant improvements must take place if reformulated gasoline is to be used after that time, assuming present planned regulations remain in place.

B. Gaseous alternative fuels

1. Natural gas

Natural gas is primarily methane as it comes from the well, and it burns quite cleanly in its unprocessed state. Natural gas has a higher ignition point (temperature) and a narrower fuel/oxygen mixture combustion range than other fuels. Energy is consumed in processing natural gas to achieve sufficient vehicle storage (i.e., compression or cryogenic processes). (See compressed natural gas and liquid natural gas below.)

2. Compressed natural gas (CNG)

CNG consists primarily of mixtures of hydrocarbon gases and vapors, principally methane (CH₄) in a gaseous form, which is compressed for use as a vehicular fuel.

a. Advantages:

- (1) Natural gas is readily available as a domestic energy source, is inexpensive and has generally developed lower emissions than most other alternative fuels.
- (2) CNG already is in use as a viable alternative for light-duty vehicles. The American Gas Association reports over 700,000 natural gas powered vehicles in operation in 38 countries.
- (3) Cleaner burning minimizes carbon buildup, thus increasing oil change intervals and reducing maintenance.

b. Disadvantages:

- (1) The pressure of CNG requires heavy storage tanks. The tanks are large even for short-range use. These two factors reduce cargo capacity. Maintaining reasonable cargo capacity restricts tank size and limits range. Lower caloric (BTU) value per equivalent gallon than diesel also limits engine efficiency and vehicle range.
- (2) The high pressure which the CNG fuel storage system must endure requires careful design and location on the vehicle, protection from damage,

plus periodic maintenance and upkeep. Periodic tank testing for structural safety is required, and tank replacement during the life cycle of the vehicle may be necessary.

- (3) Refueling time is dependent on the type of fueling system used and can be quite lengthy. There are two methods: (1) “slow-fill,” which takes from five to eight hours and is typically called “overnight” or “time-fill” refueling, and (2) “fast-fill,” which takes about five to 10 minutes and requires high-volume compression and special filling apparatus.
- (4) Natural gas compression and refueling equipment is expensive and must be maintained. Fast-fill capability requires an additional “cascade” of high volume storage cylinders, which adds considerable expense to the fueling station.
- (5) There are composition variations in natural gas and the percentage of methane content from one area to another. Additional processing is required to get uniform natural gas available in all areas.
- (6) Natural gas has poor lubricative properties.

3. Liquid natural gas (LNG)

LNG utilizes the same natural gas source (primarily methane) as CNG, but requires purification of the gas and cooling and storage below -260 degrees Fahrenheit to liquefy the natural gas. Converting natural gas to liquid form provides storage of a much greater amount on the vehicle than can be achieved in the gaseous state.

a. Advantages:

- (1) LNG has all of the combustion advantages of CNG, is readily available, clean burning and generally produces lower emissions than alternatives other than CNG.
- (2) An engine will operate just as easily on LNG as it does on CNG. Though one is stored by compression and the other by cryogenics, when

either gets to the point of combustion, it is natural gas.

- (3) The range of an LNG is greater than that of a CNG vehicle due to the fuel density.
- (4) The LNG fuel system pressure is less than 100 psig as compared to 3000 psig in a CNG system.
- (5) LNG provides almost pure methane with known performance characteristics.

b. Disadvantages:

- (1) Maintaining the super-cool temperature requires large, heavy, highly insulated tanks which forces a compromise between vehicle range and cargo carried.
- (2) Equipment to super-cool and liquefy gas is expensive to purchase, operate, and maintain.
- (3) LNG can be kept in the insulated storage tank for seven to 10 days. After that, it must be bled off to maintain the cold temperature required to hold the gas in liquid form.
- (4) The bleeding-off process releases hydrocarbons which, in turn, requires treatment to avoid direct release into the atmosphere.
- (5) Natural gas has poor lubricative properties.

4. Propane (also known as liquefied petroleum gas or LPG)

Propane, or LPG, is sometimes available directly from wells, but is normally produced as a by-product of the gasoline refining process. It has been used for a number of years in light-duty commercial vehicles in urban areas around the world.

a. Advantages:

- (1) Propane burns relatively clean. It emits less NO_x and contains less particulate matter than diesel, and emits less carbon monoxide and fewer hydrocarbons than gasoline.

- (2) The cleaner burning minimizes carbon buildup in the engine, resulting in less maintenance.
- (3) Propane starts better in cold weather than either diesel or gasoline.
- (4) The infrastructure for distribution and storage of propane is relatively widespread.

b. Disadvantages:

- (1) As with CNG, propane requires large and heavy fuel tanks to achieve reasonable driving range, due to reduced engine efficiency per equivalent gallon.
- (2) Propane requires the use of relatively low compression ratios, resulting in lower fuel economy.
- (3) Propane vapors, like gasoline, are heavier than air and are volatile. These explosive mixtures settle in service pits or other spots, therefore, indoor storage can be a safety concern.
- (4) As a by-product, propane is dependent on the gasoline process which limits supply. Further, it does little toward the reduction of dependency on foreign oil.
- (5) Propane has poor lubricative properties.

5. Electric power

The use of electricity as a power source for school buses is an emerging technology that is under considerable research due to the potential for reduced overall emissions. Research is centering on ways to increase the capacity and reduce the weight of batteries, as well as improving the motors used to power the vehicles and the associated electronics. Recharging technology is also developing rapidly. Most of these efforts have the goals of improving the range and performance of electric vehicles, reducing their cost and addressing operational concerns, such as recharging.

a. Advantages:

- (1) Electric-powered vehicles produce no tail pipe emissions.
- (2) The electricity distribution system is currently available since power lines are already in place.
- (3) Electricity can be, and often is, produced from renewable, domestic energy sources.
- (4) Electric-powered vehicles are extremely quiet, due to the lack of internal combustion engines.
- (5) Electric school buses can be produced as hybrid vehicles, which would have a small internal combustion engine to recharge batteries, or to supply heating systems or various other chassis accessories.
- (6) The cost per mile to operate electric-powered vehicles is low. In other words, power source maintenance is practically nil, compared to internal combustion engines.

b. Disadvantages:

- (1) Electric-powered vehicles have a low range due to battery weight and limited electrical storage capacity of current batteries.
- (2) Electric-powered vehicles may not eliminate overall emissions and/or foreign oil dependency if electricity to charge vehicle batteries is produced from coal or oil.
- (3) Current cost of electric power systems for vehicles, including batteries, is extremely high.
- (4) Battery disposal is an environmental concern.
- (5) Significant weight of current batteries limits passenger-carrying capacity.

BIBLIOGRAPHY

A.G.A. Requirements for Natural Gas Vehicle (NGV) Conversion Kits, No. 1-85. American Gas Association Laboratories, August 20, 1995.

An Alternative Transportation Fuel, "The LNG Option." Roy E. Adkins Cryogenic Fuels, Inc., September, 1989.

An Analysis of the Economic and Environmental Effects of Natural Gas as An Alternative Fuel, EA 1989-10. December 15, 1989.

Basic Requirements for Compressed Natural Gas Vehicle (NGV) Fuel Containers, ANSI/AGA NGV2, 1992. American Gas Association Laboratories.

"CAA Clean Fuel Fleet Requirements." Presented by Glenn W. Passavant, U.S. EPA. 1992 SAE Government/Industry Meeting, Washington, D.C., April 30, 1992.

"Campaigning for NGV's": 4th Annual Meeting Proceedings. Dallas, Texas: The Natural Gas Vehicle Coalition, June 24-25, 1992.

Compressed Natural Gas Conference Proceedings, SAE P - 129 (compilation of papers). Pittsburgh, Pennsylvania: June 22-23, 1993.

Compressed Natural Gas (CNG) Demonstration Project: Transit Facility for Buses. M.S. Consultants, Inc. for the Ohio Department of Transportation, June, 1991.

Compressed Natural Gas (CNG) Vehicular Fuel Systems, ANSI/NFPA 52 - 1988 Edition. National Fire Protection Association.

Directory of Natural Gas Vehicle Refueling Stations, Products and Services, 1991 & 1992. Editions American Gas Association.

"Putting the Future of Methanol in Proper Perspective" By J.R. Crocco - April, 1992 Presented to 1992 SAE Government/Industry Meeting, Washington, DC.

"Extent of Indoor Flammable Plumes Resulting from CNG Bus Fuel System Leaks SAE 922486" - November, 1992 By Michael J. Murphy, Susan T. Brown, & David B. Phillips-Battelle.

Florida School Bus Alternate Fuel Manual. Florida Department of Education (Suite 824, 325 West Gaines Street, Tallahassee, FL 32239-0400), 1992.

49 CFR Part 571. Federal Motor Vehicle Safety Standards. NHTSA (400 Seventh Street SW, Washington, DC 20590).

Methanol Use in School Transportation: An Expedition Through the Mind Set of America, SAE 951966 by Wayne B. Johnston and George Karbowski. Presented to SAE Future Transportation Technology Conference and Exposition, Costa Mesa, CA.

Potential for Compressed Natural Gas Vehicles in Centrally-Fueled Automobile, Truck and Bus Fleet Applications, By Michael E. Samsa. Gas Research Institute, Strategic Planning and Analysis Division, June, 1991.

Directory of National Gas Vehicle Refueling Stations, Products And Services, 1991 and 1992 Editions. American Gas Association.

Technology Conference Proceedings Dallas, Texas - June 24-25, 1992 The Natural Gas Vehicle Coalition .

Glossary of Alternative Fuels

ARB: The abbreviation for the (California) Air Resources Board, the state agency in California which sets the states emission standards.

BTU: A unit of work or energy known as a British Thermal Unit. One BTU is the energy required to increase the temperature of one pound of water by one degree Fahrenheit.

Bi-fuel: Used to describe a bus capable of running on either of two fuels, although not simultaneously. Engines which can be switched to run on either CNG or gasoline are examples.

Carbon monoxide: A product of incomplete combustion; this gas is colorless, odorless and very poisonous. It does not contribute to smog.

Catalytic converter: An exhaust after-treatment device containing a catalytic material that is used to burn off or reduce unburned fuel or gases and thus reduce emissions, particularly NO_x and hydrocarbons. Diesel converters run at cooler temperatures than do gasoline converters and require different catalysts.

Cetane number: A measure of self-ignition properties of a fuel after injection in a diesel engine. It relates to the knock properties of fuel. The higher the number, the more easily the fuel will ignite under compression; therefore, higher cetane fuels are usually preferred in diesels engines.

Combustible gas sensor: Detector capable of sensing the presence of natural gas.

Cryogenic: Relates to storage and use at very low temperatures. LNG requires cryogenic systems.

Dual-fuel engine: Also “flex fuel,” used to describe a gasoline-methanol dual-fuel engine using mixtures of gasoline and methanol, such as M85, which is 15% gasoline and 85% methanol. Dual-fuel engine can also refer to engines operating on any other mixture of fuels simultaneously, such as engines which run on a mixture of CNG and diesel.

FMVSS: Federal Motor Vehicle Safety Standard.

Formaldehyde: A chemical compound that is a by-product of combustion from engines. Concentrations may be particularly high in emissions from engines fueled by methanol.

Fumigate: Literally means “to form a gas or disperse one gas in another.” The term is used to describe the injecting of gas, usually CNG, into the intake air of the engine.

G/bhp-hr: The amount of a pollutant generated in one hour measured in grams per brake horsepower.

GVWR: Gross Vehicle Weight Rating means the value specified by the manufacturer as the loaded weight in pounds of a single vehicle, which shall not be less than the sum of the unloaded vehicle weight, plus the rated cargo load. For school buses, the rated cargo load is 120 pounds times the vehicle's designated seating capacity, plus 150 pounds for the driver.

Hydrocarbons: A gaseous compound formed by incomplete combustion and comprised of unburned and partially burned fuel. It combines with NO_x and sunlight to form ozone and is a major contributor to smog.

Lean burn: Uses more air than is needed for theoretical complete combustion. This added air allows combustion to take place at a lower temperature, thus reducing the emissions NO_x and CO.

Nebula combustion chamber: A unique high-turbulence combustion chamber in the top of a piston, which is particularly effective in efficient burning of lean gas-air mixtures.

NFPA: National Fire Protection Association

NO_x: Abbreviation for nitrogen oxides, the gaseous compounds which combine with hydrocarbons and sun light to form ozone, an air pollutant that contributes to smog.

Octane number: A measure of anti-knock properties of a fuel that relates to spark ignition engines. The higher the number, the more resistant to knocking. Higher output and more efficient engine designs can be used with higher octanes.

Ozone: A pollutant formed from NO_x, hydrocarbons and sunlight. This gas has an irritating odor, is poisonous and is used as an oxidizing agent for bleaching.

Particulate traps: An exhaust treatment device used to collect (trap) and periodically burn off particulates and other potential problem emission gases formed in engine exhaust.

Particulates: Small solid particles (soot, etc.) formed by engine combustion. Visible particulates are seen in smoke; however, invisible particles may be present in smokeless exhaust.

Pilot Ignition engine: An engine using a small quantity of diesel fuel to provide an ignition source for an alternative fuel that will not ignite on its own in a compression cycle.

Port Injection: Similar to the throttle body system except that the fuel is injected near each cylinder intake port. The injectors and their controls can be individually controlled for maximum performance and emissions control.

Reformulated gasoline: Also known as “oxygenated gasoline,” reformulated gasoline has oxygen added to improve combustion and reduce emissions.

Repower installation: A dedicated natural gas or other engine which was not part of the original chassis at the time of manufacturing.

Stoichiometric burn: Use of fuel and air (or oxygen) in the exact ratio needed for complete combustion to generate maximum efficiency and power.

Throttle body injection: A gasoline fuel injection system in which the fuel is injected directly into the air intake pipe or manifold. No carburetor is required; electronics monitor engine variables and control the rate of fuel injected.

UL: Underwriters Laboratory.

ALTERNATIVE FUELS COMPARISON CHART

	Chen Effect	Reduced Fuel Consumption	Midland	Midland	Component Fuel (CHG)	Light Natural Gas (LNG)	Propane	Electric Power
Environmental Issues								
Pro	Reduced emissions Reducing particulates reduced SO ₂ , NO _x in other regions Few safety problems	Should meet emissions regulations through year 2020 Reduced emissions in other regions	Low NO _x particulates Disperses in water and low-deposition Emissions fuel systems	Low NO _x and particulates Disperses in water and low-deposition Emissions fuel systems	Low emissions Available from the well, emissions permitting	Low emissions Available from the well, emissions permitting	Low emissions Available from the well, emissions permitting	Zero emissions Electricity often produced from renewable domestic energy sources Extremely quiet
Con	Heavily particulates and NO _x emissions Sulfur oxides (acid rain and high alkalinity) Applique emissions concentrations	Still high in energy-demanding emissions Applique emissions concentrations Non-renewable sources	Quasi-stable formulations Very toxic Emissions fuel systems	High emitting Quasi-stable formulations Very toxic Emissions fuel systems	Heavily NO _x emissions Requires energy to compress and	Heavily NO _x emissions Requires energy to supply and compress	Heavily NO _x emissions Requires energy to supply and compress	Electric power from coal and oil is not clean emissions Heavy demand is a concern
Operational Issues								
Pro	Readily available and well-distributed Midland cost less than Very efficient, good storage Useable in other regions Ample local vehicle supply	Will be readily available when required Midland cost less than Useable in other regions Ample local vehicle supply	High costs for efficient fuel systems Liquid fuels easy to distribute Stable and safe profiles	High costs for efficient fuel systems Liquid fuels easy to distribute Stable and safe profiles	Gasoline emissions available Alternative fuel cost Ample domestic supply Low engine maintenance Midland emissions based disposal quality	Beats engine costs as CHG Alternative fuel cost possible Ample domestic supply Low cost fuel system of CHG Low engine maintenance Midland emissions based disposal quality	Fully wide distribution Long-term experience in vehicle Good cold starting Low cost per mile to operate	Diesel engines closely to gas (space powertrain and transmission systems) Can be produced as hybrid vehicles Extremely quiet Low cost per mile to operate
Con	Heat cold starting Foreign oil dependency	May require new engine technology Over relies the cost per mile vs. diesel Foreign oil dependency	Corrosive breakdown Expensive repair Heat cold starting with spark ignition Limited production capability Limited fuel burning 45% energy of diesel (low range in large fuel tanks)	High cost to produce Limited production capability Limited fuel burning 30% of energy of diesel (low range in large fuel tanks)	Slow refueling Limited vehicle fuel distribution Fuel quality vehicles High-pressure on-board fuel storage, heavy and complex Limited energy and range vehicles to diesel	Slow refueling Limited availability today Cryogenic handling (-320°F) Must use fuel system after 7 to 10 hours High-pressure on-board fuel storage, heavy and complex Limited energy and range vehicles to diesel	Slow refueling Limited energy and range, vehicles to diesel Vapor barrier explosion potential	Low range due to weight and low capacity of batteries Current cost for vehicles extremely high Current vehicle weight limits passenger capacity Current technology explosion battery requirements during life of vehicle

SCHOOL BUS CHASSIS AND BODY

National School Bus Yellow

The color known as National School Bus Yellow is specified and described in the School Bus Manufacturers Technical Council publication “National School Bus Yellow Color Standard” (SBMTC-008).

Bus Body Heating System Test

1. Scope

This procedure, limited to liquid coolant systems, establishes uniform cold weather bus vehicle heating system test procedures for all vehicles designed to transport ten (10) or more passengers. Required test equipment, facilities and definitions are included. Defrosting and defogging procedures and requirements are established by SAE J381 and SAE J382, which are hereby included by reference.

1.1 Purpose

This procedure is designed to provide bus manufacturers with a cost effective, standardized test method to provide relative approximations of cold weather interior temperatures.

2. Definitions

2.1 Heat Exchanger System - Means will exist for providing heating and windshield defrosting, and defogging, capability in a bus. The system shall consist of an integral assembly, or assemblies, having a core assembly or assemblies, blower(s), fan(s), and necessary duct systems and controls to provide heating, defrosting and defogging functions. If the bus body structure makes up some portion of the duct system this structure or a simulation of this structure must be included as part of the system.

2.2 Heat Exchanger Core Assembly - The core shall consist of a liquid to air heat transfer surface(s), liquid inlet and discharge tubes or pipes.

2.3 Heat Exchanger-Defroster Blower - An air moving device(s) compatible with energies available on the bus body.

2.4 Coolant - A 50-50 solution of commercially available glycol antifreeze and commercial purity water. Commercial purity water is defined as that obtained from a municipal water supply system.

- 2.5 Heat Exchanger-Defroster Duct System** - Passages that conduct inlet and discharge air throughout the heater system. The discharge outlet louvers shall be included as part of the system.
- 2.6 Heater Test Vehicle** - The completed bus as designed by the manufacturer with, or without, a chassis, engine and driver train, including the defined heat exchanger system. If the vehicle is without a chassis, it shall be placed on the test site in such a way that the finished floor of the body is at a height, from the test site floor, equal to its installed height when on a chassis, and all holes and other openings normally filled when installed on a chassis will be plugged.
- 2.7 Heat Transfer** - The transfer of heat from liquid to air is directly proportional to the difference between the temperatures of the liquid and air entering the transfer system, for a given rate of liquid and air flow measured in pounds per minute, and that heat removed from liquid is equal to heat given to air.

3. Equipment

- 3.1 Test Site** - A suitable location capable of maintaining an average ambient temperature not to exceed 25°F (-3.9°C) for the duration of the test period. The maximum air velocity across the vehicle shall be 5 mph (8kph).
- 3.2 Coolant Supply** - A closed loop system, independent of any engine/drivetrain system, capable of delivering a 50-50 (by volume) solution of antifreeze-water, as defined in 2.4, at 150°+/-5° (65.5°+/-1.7°C) above the test site ambient temperature, and 50 lbs (22.7 kg) per minute flow. The coolant supply device shall be equipped with an outlet diverter valve to circulate coolant within the device during its warm-up period. The valve will then permit switching the coolant supply to the bus heat exchanger system at the start of the test.
- 3.3 Power Equipment Supply** - A source capable of providing the required test voltage and current for the heater system.
- 3.4 Heat Exchange Units** - The heat exchangers used shall be labeled as specified by the School Bus Manufacturer's Technical Council No. 001 (Revised 4/94). The test rating of each unit, and quantity used, shall be recorded.

4. Instrumentation

4.1 Air Temperature

4.1.1 Interior - Recommended air temperature measuring instrumentation are thermocouples or RTD's. Thermometers are not recommended because of their slow response to rapid temperature changes. Measuring instrumentation shall be placed on alternate seat rows beginning 39 in +/- 5 in (99 cm +/- 13 cm) from the

rear of the body, at 36 inches \pm 2 inches (91 cm \pm 5 cm) from the finished floor of the body, and on the longitudinal centerline of the body.

4.1.2 Ambient - A set of four (4) of electrically averaged temperature measuring devices shall be placed 18 inches \pm 5 inches (46 cm \pm 13 cm) from the nearest body surface, 96 \pm 5 in (243 cm \pm 13 cm) above the floor of test site. One measuring device shall be placed at each of the following locations:

- 1) Midline of body forward of windshield;
- 2) Midline of body aft of the rear surface; and
- 3) Midway between the axles on the right and left sides of the body.

4.1.3 Driver - Measuring devices shall be placed at appropriate locations to measure ankle, knee, and breath level temperatures with the driver's seat in rearmost, lowest and body center-most position.

- (1) Ankle Level - Place a minimum of four (4) electrically averaged temperature measuring devices at the corners of a 10 X 10 in (25 X 25 cm) square area, the rearmost edge of which begins 8 inches (20 cm) forward of the front edge of, and centered on, the seat cushion. The devices shall be located 3 inches \pm 0.5 in (7.5 cm \pm 1.3 cm) above floor surface.
- (2) Knee Level - Place a minimum of one measuring device at the height of the front top edge of the seat cushion and on the centerline of the seat. This measurement shall be 4 in \pm 1 in (10 cm \pm 2.5 cm) forward of the extreme front edge of the seat cushion and parallel to the floor.
- (3) Breath Level - Place a minimum of one measuring device 42 in \pm 2 in (107 cm \pm 5 cm) above the floor and 10 in \pm 2 in (25 cm \pm 5 cm) forward of the seat back. The forward dimension shall be measured from the upper edge of the seat back and parallel to the floor.

4.1.4 (Optional) Heat Exchanger Inlet and Outlet Temperature - A minimum of four (4) electrically averaged temperature measuring devices shall be used to measure the inlet air temperature of each heat exchange unit. Additionally, a minimum of four (4) electronically averaged temperature measuring devices shall be used to measure the outlet air temperature of each heat exchange unit. These sensors shall be placed no closer than 2.0 inches (5.1 cm) from the face of any heater core, to prevent any incidence of radiant heat transfer. Outlet sensors shall be distributed throughout the outlet air stream(s) 1.0 inches \pm .25 inches (2.5 cm \pm .6 cm) from the outlet aperture(s) of the unit heater.

4.1.5 (Optional) Defrost Air Temperature - The temperature of the defrost air shall be measured at a point in the defroster outlet(s) that is in the main air flow and which is at least one (1) inch (2.54 cm) below (upstream of) the plane of the defroster outlet opening. At least one temperature measurement shall be made in each outlet unit. The interior surface temperature(s) of the windshield shall be measured at a point located on the vertical and horizontal centerline(s) of the windshield.

- 4.1.6 (Optional) Entrance Area Temperature** - The temperature of the vehicle entrance area shall be measured by two (2) sets of three (3) each electrically averaged temperature measuring devices. One set of three devices shall be placed one (1) inches (2.54 cm) above the lowest tread of the entrance step, equally spaced on the longitudinal centerline of the tread. The second set of devices shall be placed on the next horizontal surface above the lowest entrance step, 4 inches (10.2 cm) from the outboard edge of that surface, spaced identically to the first set of sensors, and placed parallel with the outboard edge of the surface being measured.
- 4.2 Coolant Temperature** - The temperature entering and leaving the heat exchanger/defroster system shall be measured as close to the entrance and exit points of the bus body as possible with an immersion thermocouple or RTD device which can be read within $\pm 0.5^{\circ}\text{F}$ ($\pm 0.3^{\circ}\text{C}$).
- 4.3 Coolant Flow** - The quantity of coolant flowing shall be measured by means of a calibrated flow meter or weighing tank to an accuracy of at least 2 percent of setpoint.
- 4.4 Coolant Pressure** - The coolant differential pressure shall be measured by suitable connection as close as possible to the inlet and outlet of the heat exchanger/defrosting system. Pressure may be read as inlet and outlet pressure and the differential calculated, or read directly as PSID. Pressure readings shall be made with the use of gauges, manometers or transducers capable of reading within ± 0.1 psi (689.5 Pa), accurate to $\pm 0.5\%$ of full scale.
- 4.5 Additional Instrumentation** - Additional instrumentation required for vehicle heat exchanger system testing is a voltmeter and a shunt type ammeter to read the voltage and current of the complete system. The ammeter and voltmeter shall be capable of an accuracy of ± 1 percent of the reading.
- 5. Test Procedures** - Install the heater test vehicle on the test site. Testing shall be conducted in such a way as to prevent the effects of solar heating. At an outdoor test site, testing shall commence and data shall be recorded during the hours following sunset and prior to sunrise, regardless of cloud cover or facility roof. Instrumentation is required to obtain the following readings:
- (a) Vehicle interior (4.1.1).
 - (b) Inlet coolant temperature, at entrance to the bus body (4.2).
 - (c) Discharge coolant temperature, at exit from the bus body (4.2).
 - (d) Voltage and current at main bus bar connection of driver's control panel.
 - (e) Ambient temperature (4.1.2).
 - (f) Rate of coolant flow (4.3).
 - (g) Coolant flow pressure (4.4).
 - (h) Elapsed time (stop watch).
 - (i) Driver's station temperatures (4.1.3).
 - (j) (Optional) Heat Exchanger Inlet and Outlet Temperatures (4.1.4).

- (k) (Optional) Defrost Air Temperature (4.1.5)
- (l) (Optional) Entrance Area Temperature (4.1.6)

Soak the test vehicle, with doors open, for the length of time necessary to stabilize the interior temperature for a 30 minute period as recorded by the vehicle interior temperature measuring devices, and the coolant temperature as measured by the inlet and outlet coolant temperature measuring devices, at the test site temperature, $\pm 5^{\circ}\text{F}$ ($\pm 2.5^{\circ}\text{C}$), not to exceed 25°F (-3.9°C). Warm up the coolant device to the test temperature immediately prior to the start of the test. Use the coolant supply outlet diverter valve to prevent heated coolant from entering the bus heating system prior to the start of the test. At this time, set the heater controls and all fan controls at maximum, close all doors. A maximum of two windows may be left open a total of one (1) inch (2.5 cm) each. A maximum of two occupants may be in the body during the test period. Record all instrumentation readings at five minute intervals for a period of 1 hour. Recording time shall begin with the initial introduction of heated coolant from the independent coolant supply. The electrical system shall be operated at a maximum of 115% of nominal system voltage ± 0.2 volts, for example: 13.8 VDC ± 0.2 volts for a 12 VDC system, and the heat exchanger system shall be wired with the normal vehicle wiring.

Optional - Additional flow rates and/or coolant temperatures may also be used to generate supplementary data. Test procedure five (5) shall be repeated for each additional flow rate and/or coolant temperature.

6. Computations

- 6.1 Chart and Computations** - Customary Units-Data shall be recorded on Chart 6.1 or equivalent. Temperature data shall be recorded at the actual temperatures occurring at the time of testing. Air temperature data shall then be adjusted to a 0°F base prior to the construction of graphs. This data reduction shall be directly proportional to the difference between the actual ambient temperature, at the time of test, and 0°F i.e., actual ambient of 18°F shall result in a reduction of all air temperatures by 18°F , actual ambient temperature of -8°F shall result in an increase of all air temperatures by 8°F . Temperature data shall be presented in graph form as well as tabular form. One graph shall be constructed for the body interior air temperatures (4.1.1) wherein the recording intervals shall be the X-axis and the $^{\circ}\text{F}$ the Y-axis. A separate graph shall be constructed for the driver's temperatures (4.1.3) using the same units for the axes. Optional temperature data (4.1.4, 4.1.5, 4.1.6) may be similarly graphed separate from the interior data.

6.1.1 Optional Computations BTU/Hr. Coolant

1. Flow of Coolant (Ww)-lb/min-measured to ± 2 percent.
2. Temperature of Coolant into System (T-in)- $^{\circ}\text{F}$ -measured.
3. Temperature of Coolant out of System (T-out)- $^{\circ}\text{F}$ -measured.

4. Heat Removed From Coolant (Qw)-Btu/h-calculated:

$$Q_w = C_p W_w (T_{\text{in}} - T_{\text{out}}) \times 60$$

Cp= Specific Heat of Coolant - Given as 0.85 x 1.0018

BTU/lb/°F= .8515

Ww = No. 1

T-in = No. 2

T-out = No. 3

6.2 Chart and Computations - Metric Units - Data shall be recorded on Chart 6.2 or equivalent. Temperature data shall be recorded at the actual temperatures occurring at the time of testing. Air temperature data shall then be adjusted to a -18°C base prior to the construction of graphs. This data reduction shall be directly proportional to the difference between the actual ambient temperature, at the time of test, and -18°C i.e., actual ambient of -7.8°C shall result in a reduction of all air temperatures by 10.2°C, actual ambient temperature of -22.2°C shall result in an increase of all air temperatures by 4.2°C. Temperature data shall be presented in graph form as well as tabular form. One graph shall be constructed for the body interior air temperatures (4.1.1) wherein the recording intervals shall be the X-axis and °C the Y-axis. A separate graph shall be constructed for the driver's temperatures (4.1.3) using the same units for the axes. Optional temperature data (4.1.4, 4.1.5, 4.1.6) may be similarly graphed separate from the interior data.

6.2.1 Optional Computations BTU/Hr - Coolant

1. Flow of Coolant (Ww) - kg/min - measured to +/-2%.
2. Temperature of Coolant into System (T-in) - °C - measured.
3. Temperature of Coolant out of System (T-out) - °C -measured.
4. Heat Removed From Coolant Flow (Qw) - J/h - calculated:

$$Q_w = C_p W_w (T_{\text{in}} - T_{\text{out}}) \times (60)$$

Cp =Specific Heat of Coolant - Given as (0.85 x 4187j)/(kg/c)

Ww =No. 1

T-in =No. 2

T-out =No. 3.

Chart 6.1

Description of Unit _____

Purpose of Test _____

Date	Location	Observers												
Readings/Calculations		5	10	15	20	25	30	35	40	45	50	55	60	
Water														
Flow-lb/min														
Flow Pressure-PSID														
T-in °F														
T-out °F														
Air Temperature														
T1 rear- °F														
T2- °F														
T3- °F														
T4- °F														
T5- °F														
T6-front- °F														
T7-ambient- °F														
T8-Driver Ankle- °F														
T9-Driver Knee- °F														
T10-Driver Breath-°F														
Electrical System														
Volts														
Amps														

Chart 6.1-Optional Measurements

Readings/Calculations	0	5	10	15	20	25	30	35	40	45	50	55	60
T11-Windshield CL Left- °F													
T12-Windshield CL Right- °F													
T13-Defrost Outlet Left- °F													
T14-Defrost Outlet Right °F													
T15-Heater-Inlet °F													
T15-Heater-Outlet °F													
T16-Heater-Inlet °F													
T16-Heater-Outlet °F													
T17-Heater-Inlet °F													
T17-Heater-Outlet °F													
T18-Heater-Inlet °F													
T18-Heater-Outlet °F													
T19-1st Entrance Step													
T20-2nd Entrance Step													
Heat Transfer-BTU/Hr-coolant													

Chart 6.2-Optional Measurements

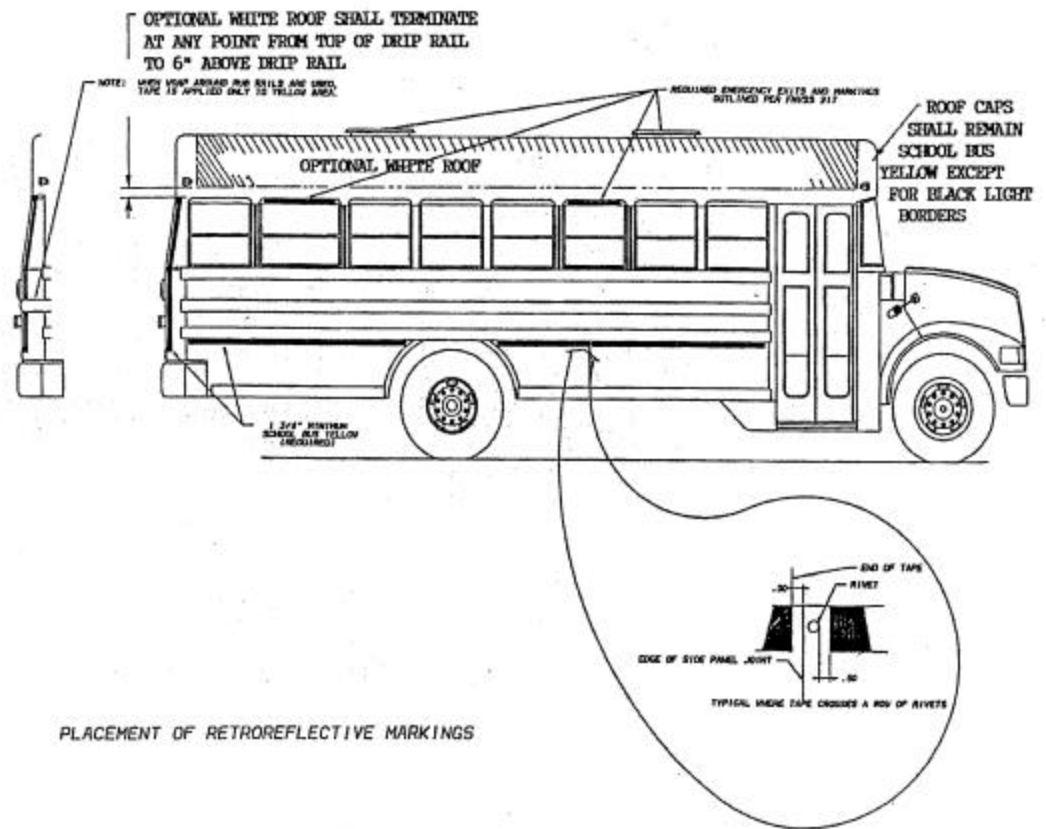
Readings/Calculations	0	5	10	15	20	25	30	35	40	45	50	55	60
T11-Windshield CL Left- °C													
T12-Windshield CL Right- °C													
T13-Defrost Outlet Left- °C													
T14-Defrost Outlet Right °C													
T15-Heater-Inlet °C													
T15-Heater-Outlet °C													
T16-Heater-Inlet °C													
T16-Heater-Outlet °C													
T17-Heater-Inlet °C													
T17-Heater-Outlet °C													
T18-Heater-Inlet °C													
T18-Heater-Outlet °C													
T19-1st Entrance Step													
T20-2nd Entrance Step													
Heat Transfer-J/Hr-coolant													

Chart 6.2

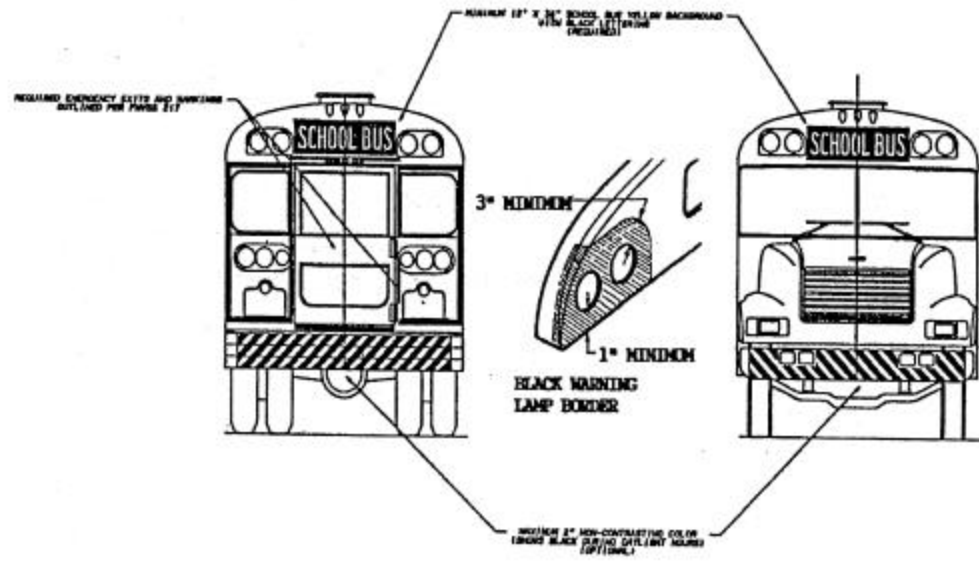
Description of Unit _____

Purpose of Test _____

Date	Location	Observers											
Readings/Calculations		5	10	15	20	25	30	35	40	45	50	55	60
Water													
Flow-kg/min													
Flow Pressure-PaD													
T-in °C													
T-out °C													
Air Temperature													
T1 extn- °C													
T2- °C													
T3- °C													
T4- °C													
T5- °C													
T6-Door- °C													
T7-ambient- °C													
T8-Driver Ankle- °C													
T9-Driver Knee- °C													
T10-Driver Heels- °C													
Electrical System													
Volt													
Amps													



PLACEMENT OF RETROREFLECTIVE MARKINGS



PLACEMENT OF RETROREFLECTIVE MARKINGS

NOISE TEST PROCEDURE

- A. The vehicle is located so that no other vehicle or signboard, building, hill or other large reflecting surface is within 15.2 m (50 feet) of the occupant's seating position.
- B. All vehicle doors, windows and ventilators are closed.
- C. All power-operated accessories are turned off.
- D. The driver is in the normal seated driving position and the person conducting the test is the only other person in the vehicle.
- E. A sound level meter is used that is set at the "A-weighting fast" meter response and meets the requirements of:
 - 1. The American National Standards Institute, Standard ANSI S1.4-1971: "Specifications for Sound Level Meters," for Type 1 Meters; or
 - 2. The International Electrotechnical Commission (IEC), Publication No. 179 (1973): "Precision Sound Level Meters."
- F. The microphone is located so that it points vertically upward 6 inches to the right and directly in line with and on the same plane as the occupant's ear, adjacent to the primary noise source.
- G. If the motor vehicle's engine radiator fan drive is equipped with a clutch or similar device that automatically either reduces the rotational speed of the fan or completely disengages the fan from its power source in response to reduced engine cooling loads, the vehicle may be parked before testing with its engine running at high idle or any other speed the operator chooses for sufficient time, but not more than 10 minutes, to permit the engine radiator fan to automatically disengage.
- H. With the vehicle's transmission in neutral gear, the engine is accelerated to:
 - 1. Its maximum governed speed, if it is equipped with an engine governor; or
 - 2. Its speed at its maximum rated horsepower, if it is not equipped with an engine governor, and the engine is stabilized at that speed.
- I. The A-weighted sound level reading on the sound level meter for the stabilized engine speed condition referred to in H.1. or H.2. above is observed and, if it has not been influenced by extraneous noise sources, is recorded.

- J. The vehicle's engine speed is returned to idle and the procedures set out in paragraphs H. and I. are repeated until two maximum sound levels within 2 dbA of each other are recorded. The two maximum sound level readings are then averaged; and
- K. The average obtained in accordance with paragraph J., with a value of 2 dbA subtracted therefrom to allow for variations in the test conditions and in the capabilities of meters, is the vehicle's interior sound level at the driver's seating position for the purposes of determining compliance with the requirements of this test procedure.

Retroreflective Sheeting Daytime Color Specificaion

The daytime color of the RETROREFLECTIVE sheeting used to enhance school bus safety requires different color tolerances in order to assure optimum safety benefit, as well as to be consistent with the color of the school bus.

The color of the RETROREFLECTIVE sheeting shall conform to the table below when samples applied to aluminum test panels are measured as specified in ASTM E1164. For colorimetric measurements, material is illuminated by Standard Illuminant D65 at an angle of 45 degrees with the normal to the surface the observations are made in the direction of the normal (45/0 degree geometry). The inverse (0/45 degree geometry) with the illuminant at the normal to the surface and the observations at 45 degrees with the normal to the surface may also be used. For materials which are directionally sensitive (e.g., prismatic sheeting), the colorimetric measurements are made using circumferential illumination and viewing and the various measurements are averaged. Calculations shall be done in accordance with ASTM E308 using the CIE 1931 (2 degree) Standard Observer.

Retroreflective Sheeting Daytime Color Chromaticity Coordinates of Corner Points Determining the Permitted Color Area

		1	2	3	4
Yellow	X	0.484	0.513	0.517	0.544
	Y	0.455	0.426	0.482	0.455
Luminance Factor (Y%)	Minimum	10.0			
	Maximum	36.0			

School Bus Seat Upholstery Fire Block Test

A. Test Chamber

Cross Section

The suggested test chamber is the same cross section as the bus body in which seats are used with the rear section on each end. If a bus section is not used, the cross section is to be 91 inches \pm 1 inch in width x 75 inches \pm 3 inches in height. There shall be a door, which does not provide ventilation, in the center of each end of the test chamber. The doors shall be 38 inches \pm 3 inches in width and 53 inches \pm 3 inches in height and include a latch to keep the doors closed during the test. (See Figure 1.)

Length

The length of the test chamber shall allow three rows of seats at the minimum spacing recommended by the installer. (See Figure 1, Detail A.)

In order that different types of seats may be tested in the same chamber. A length tolerance of plus 45 inches is allowed.

Ventilation

One ventilation opening shall be in each end of the test chamber and shall be 325 square inches \pm 25 square inches. The bottom of the opening shall be 30 inches \pm 3 inches above the chamber floor. Ventilation openings shall be on the same side of the test chamber. (See Figure 1.)

There shall be no ventilation openings along the length of the test chamber.

A forced air ventilation system may not be used.

Baffles shall be used to prevent wind from blowing directly into the ventilation openings.

Camera View Area

An opening covered with glass shall be provided at the midpoint of the test chamber length for camera viewing. The opening shall allow the camera to view the seat parallel to the seat width. (See Figure 1).

B. Test Sample

The sample shall be a fully-assembled seat.

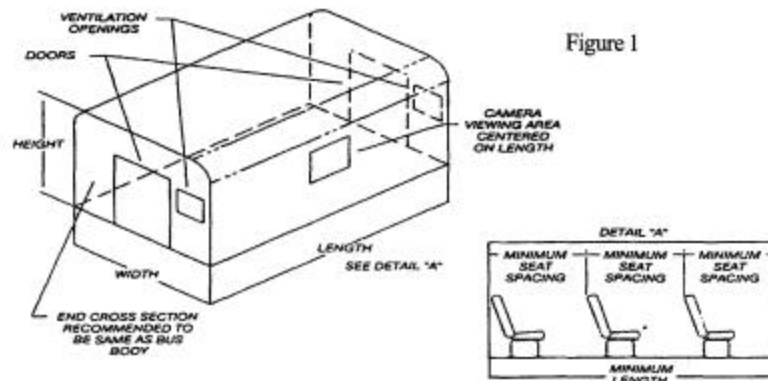
Record the weight of all padding and upholstery prior to assembly. Record the weight of the fully-assembled seat.

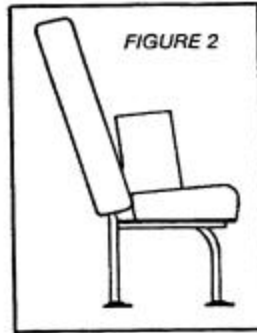
C. Ignition Source

A paper grocery bag with dimensions of approximately seven inches x 11 inches x 18 inches is used to contain double sheets of newsprint (black print only, approximately 22 inches x 28 inches). The total combined weight of bag and newspaper shall be seven ounces \pm .5 ounces.

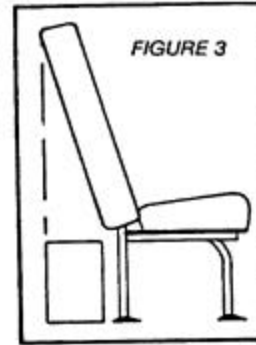
D. Test Procedure

1. Install three (3) seats in the test chamber at minimum spacing, per installer recommendation. Seats shall be perpendicular to the dimension indicated as "length" in Figure 1. Install so that seat frames will not fall during the test. Seat width shall be determined so that maximum passenger capacity per row (two (2) seats) for the seat style shall be tested.
2. For each test, position the ignition source in the following positions outlined. The widest seat in the center row shall be tested.



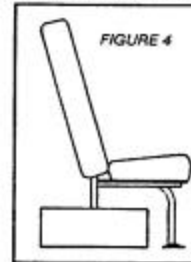


Position A.
Position ignition source with 18-inch dimension in contact with the seat cushion and touching the seat back. Center the bag on top of the cushion. (See Figure 2.)



Position B.
Position the ignition source on the floor behind the seat with 18-inch dimension on floor and parallel to seat width centered on width so that the rear of bag does not extend beyond the rear seat back. (See Figure 3.)

Position C.
Position the ignition source on the floor on the aisle side of the seat with 18-inch dimension on the floor and perpendicular to the seat width touching the seat leg with centerline of the bag at the center of the seat back. (See Figure 4.)



3. A wooden match shall be used to light the ignition source. Time the test beginning when the ignition source is on fire and ending when all flames are out.
4. After each ignition source position test, weigh seat assembly, including loose material which has fallen off the seat onto the floor.

E. Performance Criteria

For each ignition source position test, the seat tested must meet all of the following criteria. A new seat specimen may be used for each ignition source position test.

1. Maximum time from ignition to flameout shall be 8 minutes.
2. Flame shall not spread to any other seat with the ignition source in Position A and Position C.
3. Weight loss may not exceed 10 percent of the pretest weight of padding upholstery.

GUIDELINE FOR THE SAFE TRANSPORTATION OF PRE-SCHOOL AGE CHILDREN IN SCHOOL BUSES

National Highway Traffic Safety Administration
February 1999

INTRODUCTION

School age children transported in school buses are safer than children transported in motor vehicles of any other type. Large school buses provide protection because of their size and weight. Further, they must meet minimum Federal motor vehicle safety standards (FMVSSs) mandating compartmentalized seating, improved emergency exits, stronger roof structures and fuel systems, and better bus body joint strength.

As more pre-school age children are transported to school programs, often in school buses, the public is increasingly asking the National Highway Traffic Safety Administration (NHTSA) about how to safely transport them. To help answer these questions, NHTSA conducted crash testing of pre-school age size dummies in school bus seats. The test results showed that pre-school age children in school buses are safest when transported in child safety restraint systems (CSRs) that meets FMVSS 213, Child Restraint Systems, and are correctly attached to the seats.

Based on its research, NHTSA recommends pre-school age children transported in school buses always be transported in properly secured CSRs. In partial response to questions from school (and child care) transportation offices, this Guideline seeks to assist school and other transportation managers in developing and implementing policies and procedures for the transportation of pre-school age children in school buses.

Note: The proper installation of CSRs necessitates that a school bus seat have safety belts or other means of securing the CSR to the seat. NHTSA recommends that lap belts or anchorages designed to meet FMVSS 225, Tether Anchorages and Child Restraint Anchorage Systems, be voluntarily installed to secure CSRs in large school buses.

RECOMMENDATIONS FOR THE TRANSPORTATION OF PRE-SCHOOL AGE CHILDREN IN SCHOOL BUSES

When pre-school age children are transported in a school bus, NHTSA recommends these guidelines be followed:

- (1) Each child should be transported in a Child Safety Restraint System (suitable for the child's weight and age) that meets applicable Federal Motor Vehicle Safety Standards (FMVSSs).
- (2) Each child should be properly secured in the Child Safety Restraint System.

(3) The Child Safety Restraint System should be properly secured to the school bus seat, using anchorages that meet FMVSSs.

Child Safety Restraint System Defined

A Child Safety Restraint System is any device (except a passenger system lap seat belt or lap/shoulder seat belt), designed for use in a motor vehicle to restrain, seat, or position a child who weighs less than 50 pounds.

Child Safety Restraint Systems Guideline

1. Child Safety Restraint System Specifications

The provider of the CSRS should ensure:

Each pre-school age child to be transported has a CSRS appropriate for the child's weight, height, and age.

Each CSRS meets all applicable FMVSSs (look for the manufacturer's certification on the label attached to the system).

Each CSRS has been registered with the CSRS's manufacturer to facilitate any recalls the manufacturer might conduct.

If the CSRS is the subject of a recall, any necessary repairs or modifications have been made to the manufacturer's specifications.

Each CSRS is maintained as recommended by its manufacturer, including disposal of any CSRS that has been involved in a crash.

2. Proper Securement

The transportation provider should ensure:

The CSRS is used and secured correctly in the school bus.
Each child is secured in CSRSs according to manufacturer's instructions.

All CSRS attachment hardware and anchorage systems meet FMVSS 210, Seat Belt Assembly Anchorages or FMVSS 225, Tether Anchorages and Child Restraint Anchorage Systems.

School bus seats designated for CSRSs meet FMVSS 225, or include lap belts that meet FMVSS 209, Seat Belt Assemblies, and anchors that meet FMVSS 210 (designed to secure adult passengers or CSRS).

Personnel responsible for securing CSRSs onto school bus seats and children into CSRSs are properly trained and all personnel involved with CSRSs are provided up-to-date information and training.

When transported in the school bus, pre-school age children are supervised according to their developmental and functioning level.

3. School Bus Seats Designated for Child Safety Restraint Systems

The transportation provider should ensure:

School-bus seats designated for CSRSs are located starting at the front of the vehicle to provide drivers with quick access to and a clear view of the CSRS occupants.

CSRS anchorages on school bus seats should meet all applicable FMVSSs.

When ordering new school buses, the maximum spacing specified under FMVSS No. 222, School Bus Passenger Seating and Crash Protection, (within 24 inches from the seating reference point) is recommended for seats designated for CSRSs to provide adequate space for the CSRSs.

The combined width of CSRS and/or other passengers on a single seat does not exceed the width of the seat.

If other students share seats with the CSRSs, the CSRSs are placed in window seating position.

4. Retrofitting School Buses

The transportation provider should ensure:

Existing school bus seats should only be retrofitted with lap belts or child restraint anchorages as instructed by the school bus manufacturer.

When a school bus is retrofitted with a seat to allow for proper securement of a CSRS, instructions obtained from the school bus

or seat manufacturer on how to install the seat and restraint systems should be followed.

When a school bus is retrofitted, the bus owner should ensure that seat spacing is sufficient for the CSRS to be used.

5. Evacuation

The transportation provider should ensure:

The establishment of a written plan on evacuating pre-school age children and other passengers in CSRSs in the event of an emergency. This written plan should be provided to drivers, monitors, and emergency response personnel. The plan should explicitly state how children (both in and out of the CSRS) should be evacuated from the school bus.

Evacuation drills are practiced on a scheduled basis, at least as often as that required for the school system's school-aged children.

All personnel involved in transporting children are trained in evacuation and emergency procedures, including those in the written school bus evacuation plan.

All school buses carrying children in CSRSs carry safety belt cutters that are accessible only to the driver and any monitors. CSRSs are not placed in school bus seats adjacent to emergency exits.

Local emergency response teams are provided copies of the written school bus evacuation plan, including evacuation of pre-school age children. Emergency response personnel should be invited to participate in evacuation drills.

6. Other Recommendations

The school transportation provider should establish a policy on whether they or the child's guardian must supply a CSRS to be used on a school bus. School bus purchases should be based on the needs of a projected student population, taking into consideration projected ages, sizes, and other characteristics of the students, including any special needs, and whether pre-school age children or medically fragile students will be transported.

Specified procedures should be established for loading and unloading children in CSRSs.

Procedures should be established for the periodic maintenance, cleaning, and inspection for damage of CSRSs. Procedures should be established to train personnel involved in direct service delivery of infants, toddlers, and pre-school children on the physical day-to-day handling of these young children and means to handle potential exposure to contagious and communicable diseases.

When school bus procedures are established, it should be noted that some children in CSRSs may have special needs, including medical fragility, that must be addressed on a child-by-child basis.

TEST FOR FRONTAL IMPACT CRASHWORTHINESS

D.1 Purpose

This appendix specifies equipment, conditions and procedures for conducting a sled impact test to simulate the dynamic loading that Wheelchair Tiedown and Occupant Restraint System (WTORS) components used with forward-facing wheelchairs and occupants can be expected to experience in a 48-km/hr frontal crash. For WTORS designed for use with a range of wheelchair types and sizes, the test procedures specify use of a rigid, reusable surrogate wheelchair (SWC) that complies with the specifications documented and illustrated in Appendix D. For a WTORS designed only for use with a specific wheelchair having unique design features or components required by the WTORS, the test procedures provide for conducting the test with the appropriate production or prototype wheelchair. The surrogate, production, or prototype wheelchair is referred to as the test wheelchair.

D.2 Equipment To Be Tested

A complete, unused WTORS, including all fittings, anchorages, fasteners, and instructions for installation and use, shall be provided for testing. If a WTORS is designed to make use of the OEM vehicle restraint system, the WTORS manufacturer shall provide a representative vehicle restraint system for testing. If modifications to the WTORS are necessary to interface with the test wheelchair, or if changes from recommended installation geometry and/or hardware are required to interface with the sled platform, such modifications shall be made or approved by the WTORS manufacturer and shall not affect the basic structural design and dynamic strength of the WTORS.

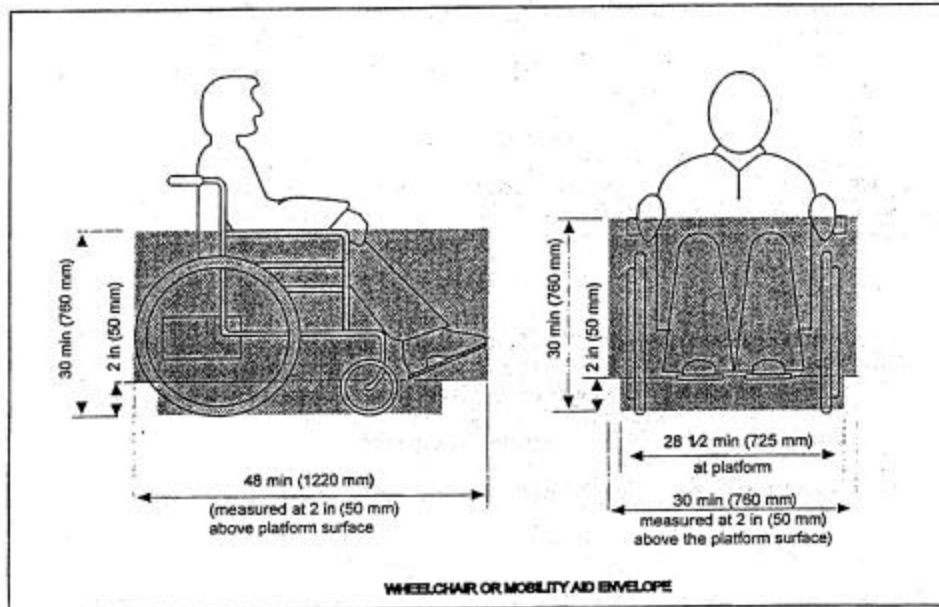
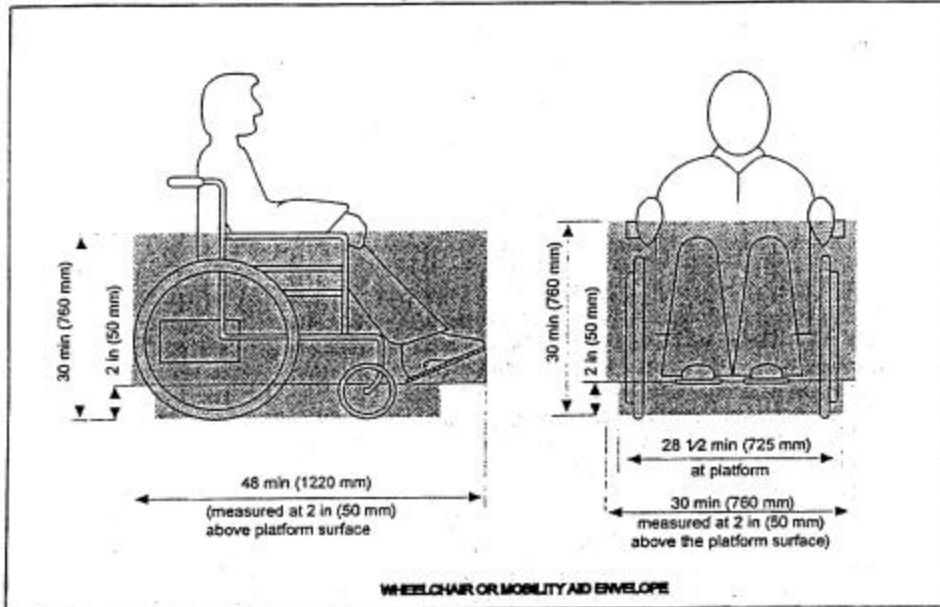
For WTORS designed to be used with a specific wheelchair, or for WTORS designed to rely on the wheelchair structure to transfer occupant restraint loads to the vehicle, a production or prototype wheelchair of the type and model required shall be provided for each test, weighted with actual or simulated components such as batteries, motors, and electronic components, as is appropriate to the style of wheelchair.

D.3 Test Equipment

The frontal impact test should be performed with impact simulator equipment that includes:

- D.3.1 An impact sled with a flat, structurally rigid platform, suitably reinforced to accept WTORS anchorages, and capable of producing the impact conditions specified in A.4.
- D.3.2 A rigid structure for anchorage of upper restraint hardware.

- D.3.3 A track or guide path to permit only unidirectional movement of the sled during the impact event.
- D.3.4 An anthropomorphic test dummy (ATD) with a total mass of 73.5 ± 1 kg. (The ATD shall simulate the response of a human occupant and shall be of a type that has proven to produce repeatable results when used in crash testing. Suitable ATDs at the time of publication are Hybrid II, Hybrid III, OPAT, and TNO-10).
- D.3.5 A test wheelchair consisting of either a surrogate wheelchair that complies with the specifications of Appendix D, or a production or prototype wheelchair as required for a specific WTORS design.



- D.3.6 High-speed camera or video equipment for recording the kinematics of the test wheelchair and the ATD at a minimum of 500 frames per second.
- D.3.7 Equipment to measure the ATD and test wheelchair horizontal excursions specified in A.7.2 to an accuracy of + 5 mm.
- D.3.8 A means to process the sled accelerometer signals as specified in A.4.2 in order to measure and record the acceleration-time history of the sled platform in the direction of sled travel during the impact event to an accuracy of + 0.5 g.
- D.3.9 A means to measure the horizontal velocity change (ΔV) during the impact deceleration/acceleration event. Mathematical integration of the deceleration-time pulse is recommended to determine the sled ΔV :

$$\Delta V = \int_{t_0}^{t_f} a(t) dt$$

where: $a(t)$ is the sled deceleration time history (i.e., sled pulse) in the impact direction,

t_0 is time-zero, the time when the sled starts to decelerate, as indicated by a sudden and final departure of $a(t)$ from zero g,

t_f is the time at which the sled deceleration pulse returns to zero (see Figure A.1).

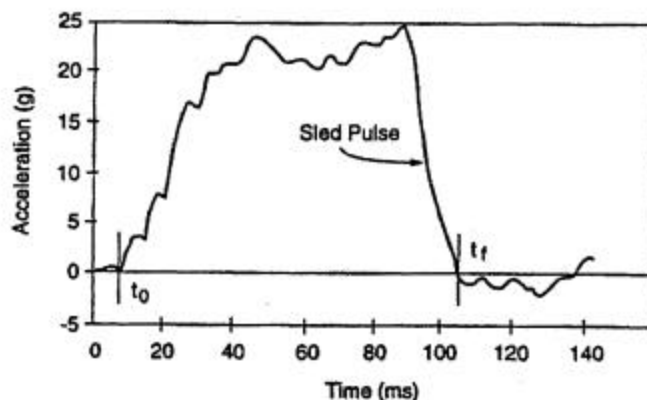
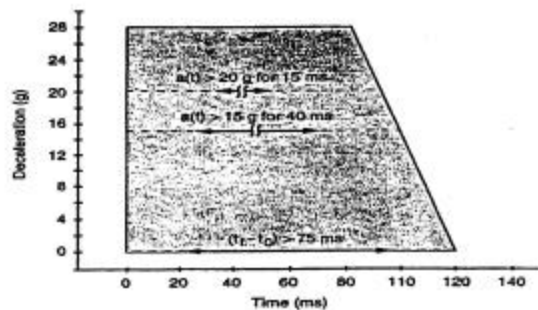


Figure A.1 - Integration limits for determining ΔV .

D.4 Sled Performance

- D.4.1 The sled platform with WTORS, test wheelchair, and ATD installed as described in D.6 shall be subjected to a horizontal velocity change of 48 km/h (+2/-0) in the direction of impact using a sled acceleration/deceleration pulse that complies with testing standards.
- D.4.2 The sled accelerometer signal shall be processed according to SAE J211 as follows:
- D.4.2.1 Prefilter to Channel Class 1000 (-4 dB at 1650 Hz),
 - D.4.2.2 Digitize at 10,000 Hz, and
 - D.4.2.3 filter digitized signal to Channel Class 60 (-4 dB at 100 Hz).
- D.4.3 The processed sled deceleration-time pulse shall:
- D.4.3.1 Fall within the shaded corridor of Figure A.2,
 - D.4.3.2 Exceed 20 g's for a cumulative time period of at least 15 ms,
 - D.4.3.3 Exceed 15 g's for a cumulative time period of at least 40 ms, and
 - D.4.3.4 Have a duration of at least 75 ms from t_0 to t_f .

Figure A.2 - Deceleration pulse corridor for a 48 (+2/-0) km/hr delta V



D.5 Preparation and Calibration of Test Equipment

Prior to conducting the test, the following shall be done:

- D.5.1 Check to make sure that the sled accelerometer has been calibrated by the manufacturer or a designated representative within six months of the test date.

- D.5.2 Calibrate the signal processing system for the sled accelerometer.
- D.5.3 Inspect the ATD to insure that all primary components are intact and functioning.
- D.5.4 Adjust the ATD to achieve a static resistance of 1 g at each joint indicated by just-noticeable movement from the weight of the distal body segment.
- D.5.5 Place snug-fitting cotton clothing on the pelvis, thighs, and torso of the ATD.
- D.5.6 If the surrogate wheelchair is used:
 - D.5.6.1 Adjust the location of the simulated battery mass to accommodate WTORS components that are fastened to the wheelchair and/or to provide adequate clearance to vehicle-anchored WTORS components,
 - D.5.6.2 Inflate the rear tires to $414 + 69$ kPa and inflate the front tires to $759 + 69$ kPa,
 - D.5.6.3 Inspect the sidewalls of the tires for abrasion and/or cracking and replace tires if worn,
 - D.5.6.4 Inspect the seat plate and plate-support structures and replace if deformed,
 - D.5.6.5 Inspect all frame joints and components and repair if there are signs of fatigue or deformation.
- D.5.7 If the test involves use of a production or prototype wheelchair:
 - D.5.7.1 Inspect and adjust the wheelchair condition according to the manufacturer's instructions.
 - D.5.7.2 Replace battery acid with water.
 - D.5.7.3 Replace electronic components and motors with equivalent masses, if desired.

D.6 Setting Up and Conducting the Test

Perform the following in sequence:

- D.6.1 Set up the high-speed camera or high-speed video system to record a lateral view of the test sled, test wheelchair, and ATD during the impact event.
- D.6.2 Fasten any wheelchair add-on components to the test wheelchair.
- D.6.3 Position the test wheelchair facing forward on the sled with wheelchair reference plane parallel to the direction of sled travel.

- D.6.4 Install the wheelchair tiedown anchorages in accordance with the manufacturer's instructions¹ on the sled platform, selecting anchorage points for strap-type systems that:
- a. Are symmetrical about the longitudinal axis of the test wheelchair;
 - b. Achieve angles of the rear tiedown straps of $45 + 3$ degrees and angles of the front tiedown straps of $60 + 3$ degrees with respect to the horizontal, measured (or projected) in a plane parallel to the wheelchair reference plane; and
 - c. Achieve angles of the rear tiedown straps of $0 + 3$ degrees and angles of the front tiedown straps of $15 + 3$ degrees (angled outward) relative to the horizontal, measured (or projected) in a vertical plane perpendicular to the wheelchair reference plane.
- D.6.5 Secure the test wheelchair in accordance with the WTORS manufacturer's instructions.
- D.6.6 Install load cells on tiedown straps if applicable and desired.
- D.6.7 Tension any tiedown straps to the manufacturer's specifications, making sure that the test wheel chair reference plane remains aligned with the direction of sled travel.

¹ If fasteners provided with the WTORS are incompatible with the sled platform, replacement fasteners shall be of the same thread size and specification. The anchor bolt may also be fastened directly into a tapped hole in the sled platform.

- D.6.8 Position the ATD in the test wheelchair sitting upright and symmetrically positioned about the wheelchair midline, with the pelvis and elbows as close to the seatback of the test wheelchair as possible.
- D.6.9 Install the occupant restraint system in accordance with the manufacturer's instructions,
- a. Selecting anchor points for the pelvic belt to achieve angles within the range specified in Figure 7 of this document; and
 - b. Selecting anchor points for the upper torso belt within the preferred zone or zones shown in Figures 8, 9, or 10, as applicable.
- D.6.10 Install belt-webbing load cells on occupant restraint belts if desired.
- D.6.11 If an emergency-locking or automatic-locking retractor is provided, adjust the pelvic restraint for minimum slack. If no emergency-locking or automatic-locking retractor is provided, adjust the tension of the pelvic restraint to a snug fit over the ATD's pelvis.

- D.6.12 If an emergency-locking or automatic-locking retractor is provided, adjust the shoulder belt for minimum slack or minimum preloading. If no emergency-locking or automatic-locking retractor is provided, adjust the shoulder belt to a snug fit with a 75 x 75 x 75 mm block placed between the belt and the ATD's sternum.
- D.6.13 Mark the webbing at WTORS adjustment mechanisms to determine slippage during the test.
- D.6.14 Position high-contrast targets on the sides of the ATD and test wheelchair in view of the high-speed recording equipment at:
- The lateral aspect and center of the ATD's knee joint;
 - The point P of the surrogate wheelchair (see Figure 1 and Figures D.1 through D.3 in Appendix D); or
 - A point on the side of the seatback of a production or prototype wheelchair that is as close to the wheelchair point P as possible.
- D.6.15 Verify that the test wheelchair reference plane is aligned within + 3 degrees of the direction of sled travel.
- D.6.16 Record the locations of all WTORS anchor points relative to the test wheelchair and the angles of all tiedown straps and pelvic restraint belts relative to the horizontal longitudinal axis of the sled platform.
- D.6.17 Conduct the impact test.

D.7 Measurement and Calculation of Test Results

After the test:

- D.7.1 Examine the test wheelchair, ATD, and WTORS components to determine and/or measure:
- D.7.1.1 Whether the ATD remained in the test wheelchair;
 - D.7.1.2 Whether the test wheelchair remained on the test platform;
 - D.7.1.3 Any change in orientation of the test wheelchair reference plane relative to the direction of sled travel;
 - D.7.1.4 Any slippage at each WTORS adjustment mechanism;
 - D.7.1.5 Whether any load-carrying parts became separated, deformed, or fractured;
 - D.7.1.6 If the ATD and test wheelchair could be released from the WTORS without the use of tools.
- D.7.2 Analyze the high-speed films or video recordings to determine the following with an accuracy of + 5 mm:

- D.7.2.1 $Ex_{head_{peak}}$ = the horizontal distance relative to the sled platform between the most forward point on the ATD's head above the nose at time to, to the most forward point on the ATD's head at the time of peak head excursion;
 - D.7.2.2 $Ex_{knee_{peak}}$ = the horizontal distance relative to the sled platform between the ATD knee-joint target at time to, to the knee-joint target at the time of peak knee excursion; and
 - D.7.2.3 $Ex_{WC_{peak}}$ = the horizontal distance relative to the sled platform between the contrast target placed at or near point P on the test wheelchair at time to, to the point P target at the time of peak wheelchair excursion.
- D.7.3 Calculate the ratio $(Ex_{knee_{peak}})/(Ex_{WC_{peak}})$.

D.8 Test Report

The test report should include:

- D.8.1 A description of the test facility including the type of impact simulated, instrumentation and signal processing techniques, the frame speed for each film and/or video produced, methods for measuring sled velocity change and deceleration, methods used to measure ATD and test wheelchair excursions, and the accuracy of excursion measurements;
- D.8.2 A full identification of the WTORS, anchorage fasteners, test wheelchair, and ATD used;
- D.8.3 Pre-test measurements documenting the locations of all WTORS anchorages relative to the test wheelchair and angles of all tiedown straps and pelvic restraint belts relative to the horizontal and measured in vertical planes perpendicular to, or parallel to, the wheelchair reference plane, as appropriate;
- D.8.4 The angles of all tiedown straps and pelvic restraint belts relative to the horizontal obtained by projecting the actual angles onto a vertical plane perpendicular to the wheelchair reference plane (side view) and a vertical plane perpendicular to the wheelchair reference plane (front or rear view);
- D.8.5 A description of the test setup including a statement about any parts or fasteners used in the test that were not provided by the WTORS manufacturer;
- D.8.6 Whether the ATD remained in the test wheelchair;

- D.8.7 Whether the test wheelchair remained on the test platform;
- D.8.8 The change in the orientation of the test wheelchair reference plane, if measurable, in comparison with the initial test orientation;
- D.8.9 Identification of any WTORS load-carrying parts that became separated, deformed, or fractured during the test;
- D.8.10 The webbing slippage in millimeters at each WTORS adjustment mechanism;
- D.8.11 The peak horizontal excursions specified in D.7.2, and whether any of the excursions exceeded the limits in Table 2 of this recommended practice;
- D.8.12 A statement as to whether the ATD and test wheelchair could be released from the WTORS without the use of tools;
- D.8.13 A statement as to whether the ATD was loaded by the test wheelchair based on the results of the calculation in 6.2.4;
- D.8.14 A statement as to whether the WTORS complied with all of the performance requirements specified in 6.2 of this recommended practice;
- D.8.15 A graph of the sled deceleration time history for the test in relation to the deceleration corridor of Figure A.2; and
- D.8.16 The measured or calculated value of the test delta V.

D.9 Performance Requirements

D.9.1 WTORS Components

- D.9.1.1 All webbing, metal parts, buckles, release mechanisms, and adjustment mechanisms of wheelchair tiedown and occupant restraint systems shall comply with applicable subsections of No. FMVSS 209 as indicated in Table 1.
- D.9.1.2 All materials used in WTORS shall comply with the flammability requirements of FMVSS No. 302.

Table 1
Applicable Subsections of FMVSS No. 209

Table 1
Applicable Subsections of FMVSS No. 209

Section	Component	Subject	Tests Referenced	Application*
S4.1 (a)	general design	occupancy	-	R
S4.1 (b)	pelvic restraint	design	-	R
S4.1 (c)	upper torso restraint	design	-	R
S4.1 (d)	hardware	burrs & sharp edges	-	R + TD
S4.1 (e)	release mechanism	design	-	R
S4.1 (g)	restraint assemblies	adjustment range	-	R
S4.1 (h)	webbing	unraveling	-	R + TD
S4.2 (a)	webbing	belt width	S5.1 (a)	R
S4.2 (b)	webbing	breaking strength	S5.1 (b)	R
S4.2 (c)	webbing	elongation	S5.1 (c)	R
S4.2 (d)	webbing	abrasion resistance	S5.1 (d), S5.3 (c)	R
S4.2 (e)	webbing	light resistance	S5.1 (e)	R + TD
S4.2 (f)	webbing	micro. resistance	S5.1 (f)	R + TD
S4.2 (g)	webbing	colorfastness	S5.1 (g)	R + TD
S4.2 (h)	webbing	stain resistance	S5.1 (h)	R + TD
S4.3 (a)	hardware	corrosion resistance	S5.2 (a)	R + TD
S4.3 (b)	hardware	temp. resistance	S5.2 (b)	R + TD
S4.3 (c)	floor fasteners	breaking loads	S5.2 (c)	R + TD
S4.3 (d)	buckle release	release force	S5.2 (d)	R
S4.3 (e)	adjustment device	adjustment force	S5.2 (e)	R + TD
S4.3 (f)	tilt-lock devices	locking angles	S5.2 (f)	R
S4.3 (g)	buckle latch	separation force	S5.2 (g)	R
S4.3 (h)	belt retractor	performance	S5.2 (h)	R
S4.3 (i)	belt retractor	performance	S5.2 (i)	R
S4.3 (j)	belt retractor	performance	S5.2 (j)	R
S4.3 (k)	belt retractor	performance	S5.2 (k), S4.4	R
S4.4 (a)	pelvic restraints	performance	S5.3 (a)	R
S4.4 (b)	3-pt restraints	performance	S5.3 (b)	R

* R = occupant restraint; TD = wheelchair tie-down

D.10 Frontal Sled Impact Test

When tested as specified in Appendix A, the WTORS shall:

- D.10.1 Retain the test dummy in the test wheelchair and on the test sled with the test wheelchair in an upright position;
- D.10.2 Not show any fragmentation or complete separation of any load carrying part; and
- D.10.3 Not allow the horizontal excursions of the test dummy and the test wheelchair to exceed the values given in Table 2.

Table 2
Horizontal Excursion Limits (mm)

Measurement Point	Excursion Variable	Pelvic & Shoulder Restraint
Test wheelchair	ExWC _{peak}	200
Dummy Knee	ExKnee _{peak}	375
Dummy Head	Exhead _{peak}	650

where,

Exhead_{peak} = the horizontal distance relative to the sled platform between the most forward point on the dummy's head above the nose at time t_0 , to the most forward point on the dummy's head at the time of peak head excursion,

Exknee_{peak} = the horizontal distance relative to the sled platform between the dummy knee-joint target at time t_0 , to the knee joint target at the time of peak knee excursion, and

ExWC_{peak} = the horizontal distance relative to the sled platform between the contrast target placed at or near point P on the test wheelchair at time t_0 , to the point P target at the time of peak wheelchair excursion.

- D.10.4 Prevent the wheelchair from imposing forward loads on the occupant as indicated by:

$$(\text{Exknee}_{\text{peak}})/(\text{ExWC}_{\text{peak}}) > 1.1$$

- D.10.5 Allow removal of the anthropomorphic test dummy and the test wheelchair subsequent to the test without the use of tools.

D.11 Partial Engagement of Anchorage and Securement Components

When WTORS anchorage and securement components are tested as specified in Appendix B, all improper and partial engagements shall separate with a force of less than 22 N.

D.12 Webbing Slippage at Tiedown Adjustment Devices

When the webbing adjustment mechanisms of the wheelchair tiedown system shall not show slippage greater than 25 mm.

SPECIFICATIONS FOR SURROGATE WHEELCHAIR

D.1 Purpose

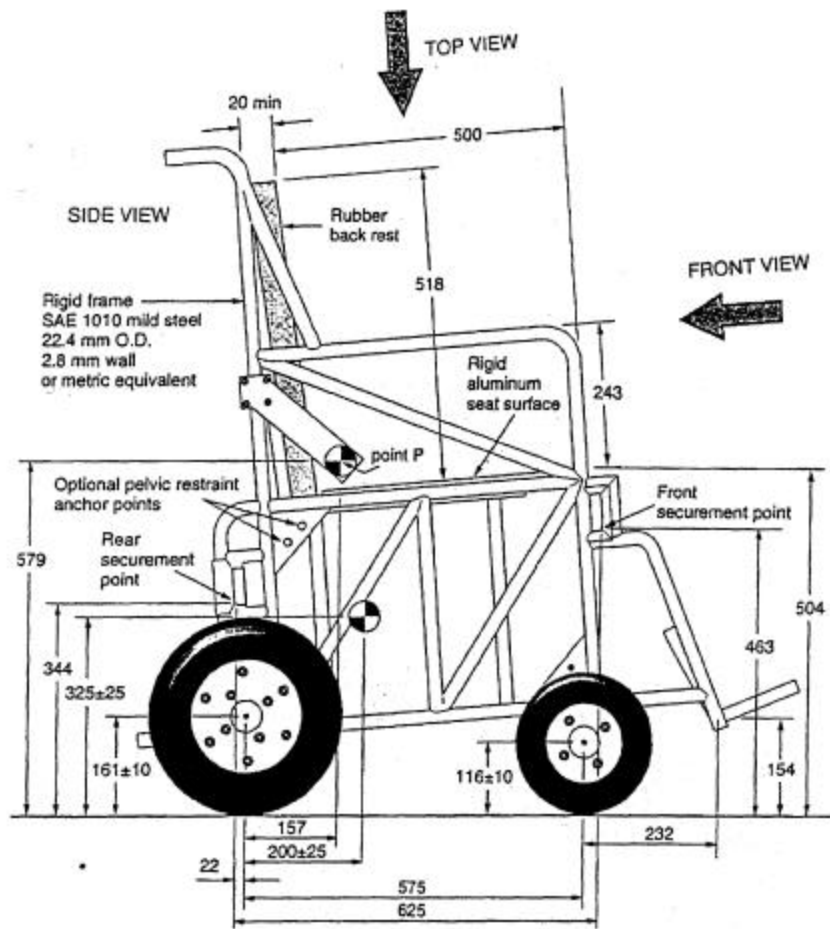
This appendix provides design, dimensional, material, and performance specifications for the surrogate wheelchair (SWC) referenced in the design requirements and tests of this recommended practice. These specifications are intended to provide a repeatable and reusable device that represents a typical adult-sized power wheelchair. Details for the design, fabrication, and maintenance of a suitable surrogate wheelchair are available in SAE J2252 - Surrogate Wheelchair Drawing Package and Maintenance Manual.

D.2 Specifications

The surrogate wheelchair shall be designed and fabricated with the features, dimensions, and specifications shown in Figures D.1 through D.3, and shall:

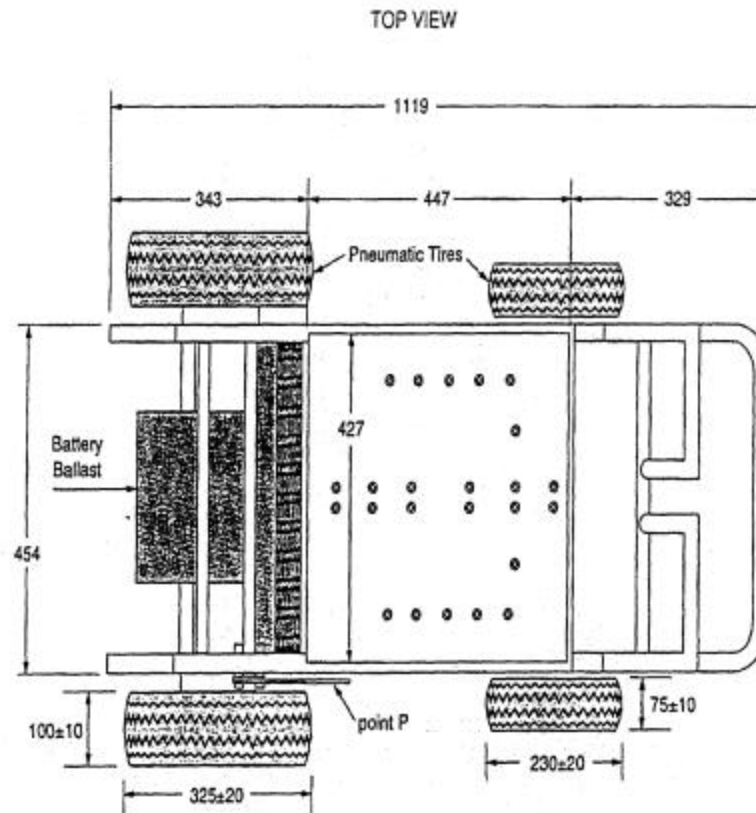
- D.2.1 Be of rigid construction;
- D.2.2 Have a total mass of $85 + 1$ kg;
- D.2.3 Have a lower frame design that is compatible with WTORS components of docking-type and clamp-type wheelchair tiedowns with little or no modification to those components;
- D.2.4 Allow for adjustment in the SWC-to-floor clearance distance to accommodate wheelchair anchorage components of docking-type tiedown systems;
- D.2.5 Have a center of gravity located $200 + 25$ mm forward of the rear axle and $325 + 25$ mm above the ground plane for the range of frame-to-floor clearance adjustments allowed;
- D.2.6 Provide two front securement points and two rear securement points for strap-type tiedowns at the locations indicated in Figure D.1 and with the geometry specified in Figure F.1 of Appendix F;
- D.2.7 Provide accessible and structurally sound locations $250 + 10$ mm above the ground plane for the addition of two rear securement points that simulate the horizontal axles a standard welded-Frame wheelchair and that are perpendicular to the surrogate wheelchair sideframe;
- D.2.8 Provide pelvic restraint anchor points on both sides that are located so that the angle of a pelvic restraint bolted to these points and placed over the pelvis of a 50th-percentile-male ATD seated in the surrogate wheelchair forms an angle between 45 and 60 degrees to the horizontal;

- D.2.9 Have a rigid, flat seat surface with dimensions shown in Figures D.2 that is oriented at an angle of $4 + 1.5$ degrees to the horizontal (front end up) when the SWC tires are resting on a flat horizontal surface;
- D.2.10 Have a rigid seatback with height and width dimensions indicated in Figure D.3 that is oriented at $8 + 1.5$ degrees to the vertical when the inflated tires of the SWC are resting on a flat horizontal surface;
- D.2.11 Have a 20-mm minimum thickness, perforated rubber pad with height and width dimensions indicated in Figures D.1 and D.3 fixed to the front surface of the rigid seatback;
- D.2.12 Be of durable construction such that there is no permanent deformation of the frame, seat surface, or seatback in a 48-km/h, 20-g frontal impact test with a 50th-percentile, 73.5 kg ATD positioned and restrained in the SWC;
- D.2.13 Have a detachable but rigid mounting plate for placement of a side-view contrast target at the location of reference point P outboard of tiedown and restraint system components on either side of the SWC;
- D.2.14 Have pneumatic front tires that, when inflated to 759 kPa, have a diameter of $230 + 10$ mm, a width of $75 + 5$ mm, and a sidewall height of $54 + 5$ mm;
- D.2.15 Have pneumatic rear tires that, when inflated to 414 kPa, have a diameter of $325 + 10$ mm, a width of $100 + 10$ mm, and a sidewall height of $70 + 5$ mm; and
- D.2.16 Include hard rubber stops located inboard of each rear wheel to limit rear tire compression during the frontal impact test of Appendix A to $45 + 5$ mm.



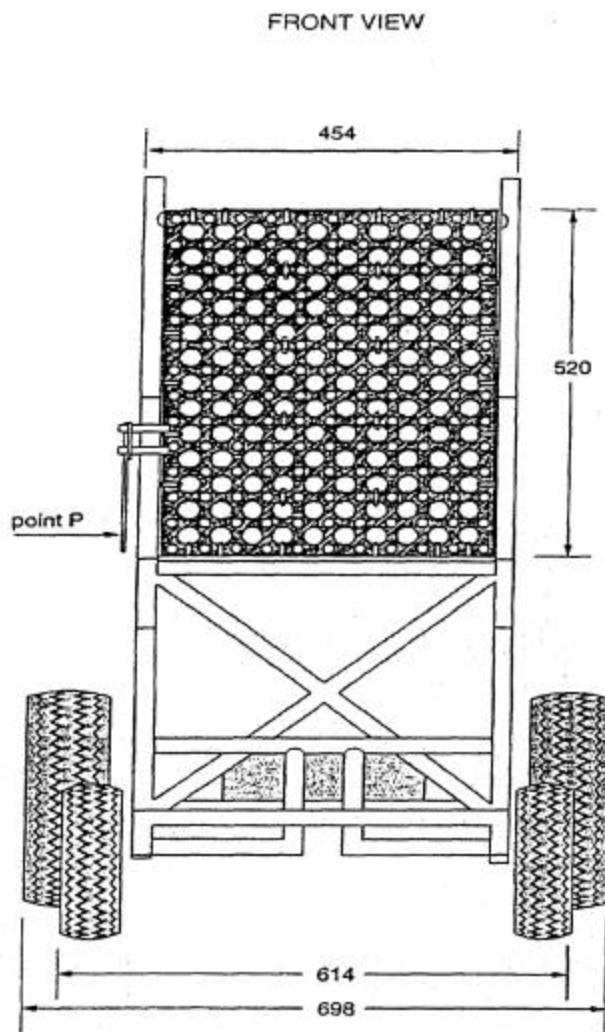
all dimensions are in mm with tolerances of ± 2 mm unless specified

Figure D.1 - Side-view drawing of surrogate wheelchair.



all dimensions are in mm with tolerances of ± 2 mm unless specified

Figure D.2 - Top-view drawing of surrogate wheelchair.



all dimensions are in mm with tolerances of ± 2 mm unless specified

Figure D.3 - Front-view drawing of surrogate wheelchair.

Vehicle Ramp 36 CFR 1192.23

- (1) **Vehicle ramp:** -(1) Design Load. Ramps 30 inches or longer should support a load of 600 pounds, placed at the centroid of the ramp distributed over an area of 26 inches by 26 inches, with a safety factor of at least 3 based on the ultimate strength of the material. Ramps shorter than 230 inches shall support a load of 300 pounds.
- (2) **Ramp Surface:** The ramp surface shall be continuous and slip resistant,, shall not have protrusions from the surface greater than ¼ inch high, shall have a clear width of 30 inches, and shall accommodate both four-wheel and three-wheel mobility aids.
- (3) **Ramp threshold:** The transition from roadway or sidewalk and the transition from vehicle floor to the ramp may be vertical without edge treatment up to ¼. Changes in level between ¼ inch and ½ inch shall be beveled with a slope no greater than 1:2.
- (4) **Ramp barrier:** Each side of the ramp shall have barriers at least 2 inches high to prevent mobility aid wheels from slipping off.
- (5) **Slope:** Ramps shall have the least slope practicable and shall not exceed 1:4 when deployed to ground level. If the height of the vehicle floor from which the ramp is deployed is 3 inches or less above a 6-inch curb, a maximum slope of 1:4 is permitted; if the height of the vehicle floor from which the ramp is deployed is 6 inches or less, but greater than 3 inches, above a 6-inch curb, a maximum slope of 1:6 is permitted; if the height of the vehicle floor from which the ramp is deployed is 9 inches or less, but greater than 6 inches, a maximum slope of 1:8 is permitted; if the height of the vehicle floor from which the ramp is deployed is greater than 9 inches above a 6-inch curb, a slope of 1:12 shall be achieved. Folding or telescoping ramps are permitted provided they meet all structural requirements of this section.
- (6) **Attachment:** When in use for boarding or alighting, the vehicle so that if is not subject to displacement when loading or unloading a heavy power mobility aid and that no gap between vehicle and ramp exceeds 5/8 inch.
- (7) **Stowage:** A compartment, securement system, or other appropriate method shall be provided to ensure that stowed ramps, including portable ramps stowed in the passenger area, do not impinge on a passenger's wheelchair or mobility aid or pose any hazard to passengers in the event of a sudden stop or maneuver.
- (8) **Handrails:** If provided, handrails shall allow persons with disabilities to grasp them from outside the vehicle while starting to board, and to continue to use them throughout the boarding process, and shall have the top between 30 inches and 38 inches above the ramp surface. The handrails shall be capable of withstanding a force of 100 pounds concentrated at any point on the handrail without permanent deformation of the rail or its supporting structure. The handrail shall have a cross-sectional diameter between 1-1/4 inches and 1-1/2 inches or shall provide an equivalent grasping surface, and have eased edges with corner radii of not less than 1/8 inch. Handrails shall not interfere with wheelchair or mobility aid maneuverability when entering or leaving the vehicle.

Appendix, Vehicle

American Society for Testing and Materials
1916 Race Street
Philadelphia, PA 19103

Federal Specification TT-C-520b
General Services Administration
Specifications and Consumer Information
Distribution Center
Washington Navy Yard
Building 197
Washington, D.C. 20407

Product Standard PSI-66
U.S. Department of Commerce
14th and E Streets
Washington, D.C. 20230

School Bus Manufacturers Technical Council
National Association of State Directors of Pupil Transportation Services
116 Howe Drive
Dover, DE 19901
1-800-585-0341

Society of Automotive Engineers, Inc.
400 Commonwealth Drive
Warrendale, PS 15096

Underwriters Laboratories, Inc.
333 Pfingsten Road
Northbrook, IL 60062



Missouri Department of Elementary and Secondary Education
P.O. Box 480 • Jefferson City, Missouri 65102-0480
<http://www.dese.state.mo.us>